OSU
Oregon State
UNIVERSITY

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October 27, 2004

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Reference: Oregon State University TRIGA Reactor (OSTR) Docket No. 50-243, License No. R-106

In accordance with section 6.7.e of the OSTR Technical Specifications we are hereby submitting the Oregon State University Radiation Center and TRIGA Reactor Annual Report for the period July 1, 2003 through June 30, 2004.

The Annual Report continues the pattern established over the past few years by including information about the entire Radiation Center rather than concentrating primarily on the reactor. Because the report addresses a number of different interests, it is rather lengthy, but we have incorporated a short executive summary which highlights the Center's activities and accomplishments over the past year.

The executive summary indicates that the Radiation Center has had yet another successful and productive year. I would like to emphasize that the achievements of this last year would not have been possible without the support and assistance we received from the invaluable programs administered by the USDOE. In particular, the Reactor Sharing program and the University Research Reactor Upgrades program are very cost-effective in providing invaluable support to the university reactor community and its users.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on: October 27, 2004

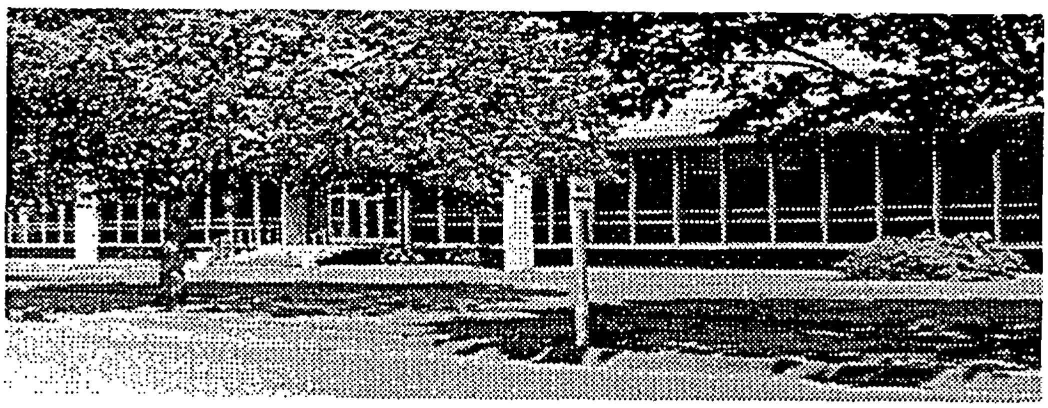
Sincerely,

Andrew C. Klein
Director

lm:srr
Enclosure
cc: Alexander Adams
Craig Bassett
David Stewart-Smith
Edward Ray
Rich Holdren
Sabah Randhawa
Steve Reese
Gary Wachs
Shirley Campbell
Robin Keen

A020

Oregon State University Radiation Center and TRIGA Reactor



Annual Report

July 1, 2003 - June 30, 2004

Annual Report of the Oregon State University Radiation Center and TRIGA Reactor

July 1, 2003 - June 30, 2004

To satisfy the requirements of:

A. U.S. Nuclear Regulatory Commission, License No. R-106 (Docket No. 50-243), Technical Specification 6.7(e).

B. Task Order No. 3, under Subcontract No. C84-110499 (DE-AC07-76ER01953) for University Reactor Fuel Assistance-AR-67-88, issued by EG&G Idaho, Inc.

C. Oregon Office of Energy, OOE Rule No. 345-030-010.

Submitted by:

A. C. Klein
Director, Radiation Center

Radiation Center
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Corvallis, Oregon 97331-5903
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Annual Report of the
Oregon State University
Radiation Center and TRIGA Reactor

Table of Contents

Page

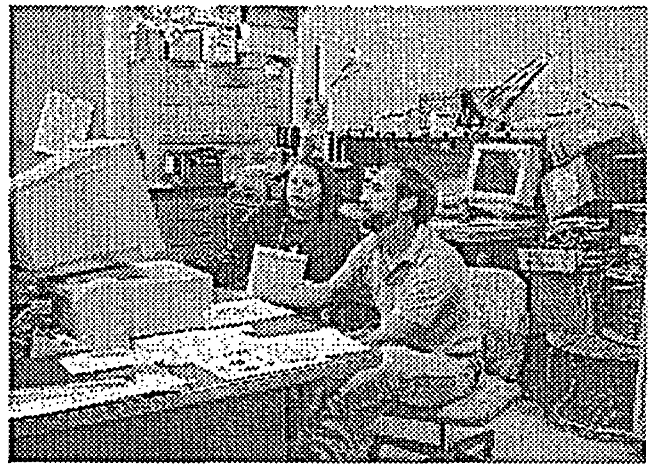
LIST OF TABLES

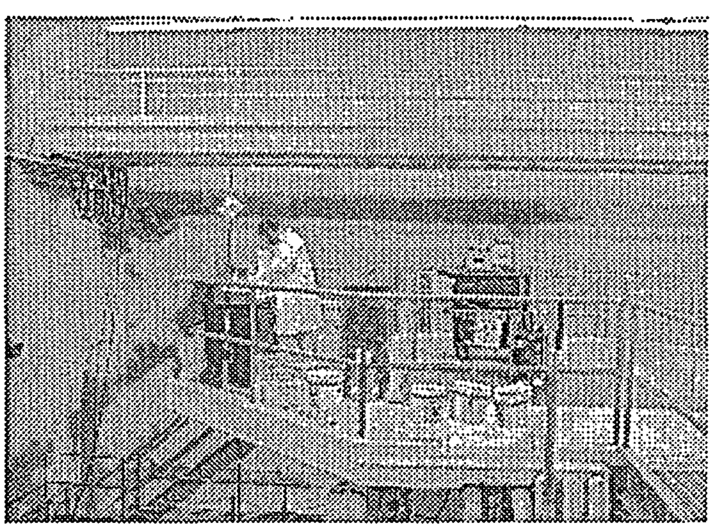
LIST OF TABLES (Continued)

LIST OF FIGURES

Part I

Overview





Part I

OVERVIEW

A. Acknowledgments

Many individuals and organizations help the Radiation Center succeed, and in recognition of this, the staff of the Oregon State University (OSU) Radiation Center and TRIGA Reactor (OSTR) would like to extend its appreciation to all of those who contributed to the information and events contained in this report: to the University administration; to those who provided our funding, particularly the U. S. Department of Energy (USDOE) and the State of Oregon; to our regulators; to the researchers, the students, and others who used the Radiation Center facilities; to OSU Facilities Services; and to OSU Department of Public Safety and the Oregon State Police. We most earnestly say, "Thank you."

Putting this report together each year is a major effort for two people. This year, the burden of collecting the information, "twisting arms," and generally producing the extensive document before you was placed upon LaVon Mauer. Erin Cimbri has once again made collecting the information much easier by automating many of the tables in this report. The amount of person-hours she has saved all of us over the years is more than we probably would like to admit. A special "thanks" goes out to both of them.

B. Executive Summary

The data from this reporting year show that the use of the Radiation Center and OSTR has continued to grow in many areas.

The Radiation Center supported 71 different courses this year, mostly in the Department of Nuclear Engineering. About 20% of these courses involved the OSTR. The number of OSTR hours used for academic courses and training was 16, while 1998 hours were used for research projects. Sixty percent of the OSTR research hours were in support of off-campus research projects, which reflects the use of the OSTR nationally and internationally. Radiation Center users published 56 articles this year, with 7 more submitted for publication. There were also 35 theses completed and 56 presentations made by Radiation Center users. The number of samples irradiated in the reactor during this reporting period was 1845.. Funded OSTR use hours comprised 99% of the research use.

Personnel at the Radiation Center conducted 111 tours of the facility, accommodating 2075 visitors. The visitors included elementary, middle school, high school, and college students;

relatives and friends; faculty; current and prospective clients; national laboratory and industrial scientists and engineers; and state, federal and international officials. The Radiation Center is a significant positive attraction on campus because visitors leave with a good impression of the facility and of Oregon State University.

The Radiation Center projects database continues to provide a useful way of tracking the many different aspects of work at the facility. The number of projects supported this year was 180 Reactor projects comprised 74% of all projects. The total research supported by the Radiation Center, as reported by our researchers, was $5,999,860. The actual total is likely considerably higher. This year the Radiation Center provided service to 72 different organizations/ institutions, 42% of which were from other states and 18% of which were from outside the U. S. and Canada. So while the Center's primary mission is local, it is also a facility with a national and international clientele.

The Radiation Center web site provides an easy way for potential users to evaluate the Center's facilities and capabilities as well as to apply for a project and check use charges. The address is: http://www.ne.orst.edu/facilities/radiation_center.

C. Introduction

The current annual report of the Oregon State University Radiation Center and TRIGA Reactor follows the usual format by including information relating to the entire Radiation Center rather than just the reactor. However, the information is still presented in such a manner that data on the reactor may be examined separately, if desired. It should be noted that all annual data given in this report cover the period from July 1, 2003 through June 30, 2004. Cumulative reactor operating data in this report relate only to the FLIP-fueled core. This covers the period from August 1, 1976 through June 30, 2004. For a summary of data on the reactor's original 20% enriched core, the reader is referred to Table IV.A.2 in Part IV of this report or to the 1976-77 Annual Report if a more comprehensive review is needed.

In addition to providing general information about the activities of the Radiation Center, this report is designed to meet the reporting requirements of the U. S. Nuclear Regulatory Commission, the U. S. Department of Energy, and the Oregon Department of Energy. Because of this, the report is divided into several distinct parts so that the reader may easily find the sections of interest.

D. Overview of the Radiation Center

The Radiation Center is a unique facility which serves the entire OSU campus, all other institutions within the Oregon University System, and many other universities and organizations throughout the nation and the world. The Center also regularly provides special services to state and federal agencies, particularly agencies dealing with law enforcement, energy, health, and environmental quality, and renders assistance to Oregon industry. In addition, the Radiation Center provides permanent office and laboratory space for the OSU Department of Nuclear Engineering, the OSU Radiation Safety Office, the OSU Institute of Nuclear Science and Engineering and Radiation Health Physics, and for the OSU nuclear chemistry, radiation chemistry, geochemistry and cosmochemistry programs. *There is no other university facility with the combined capabilities of the OSU Radiation Center in the western half of the United States.*

Located in the Radiation Center are major items of specialized equipment and unique teaching and research facilities. They include a TRIGA Mark II research nuclear reactor; a ^{60}Co gamma irradiator; a large number of state-of-the art computer-based gamma radiation spectrometers and associated germanium detectors; and a variety of instruments for radiation measurements and monitoring. Specialized facilities for radiation work include teaching and research laboratories with instrumentation and related equipment for performing neutron activation analysis and radiotracer studies; laboratories for plant experiments involving radioactivity; a facility for repair and calibration of radiation protection instrumentation; and facilities for packaging radioactive materials for shipment to national and international destinations.

A major non-nuclear facility housed in the Radiation Center is the one-quarter scale thermal hydraulic advanced plant experimental (APEX) test facility for the Westinghouse AP600 reactor design. The AP600 is a next-generation nuclear reactor design which incorporates many passive safety features as well as considerably simplified plant systems and equipment. APEX operates at pressures up to 400 psia and temperatures up to 450°F using electrical heaters instead of nuclear fuel. All major components of the AP600 are included in APEX and all systems are appropriately scaled to enable the experimental measurements to be used for safety evaluations and licensing of the full scale plant. This world-class facility meets exacting quality assurance criteria to provide assurance of safety as well as validity of the test results.

Also housed in the Radiation Center is the Advanced Thermal Hydraulics Research Laboratory, which is used for state-of-the-art two-phase flow experiments, and the Nuclear Engineering Scientific Computing Laboratory.

The Radiation Center staff regularly provides direct support and assistance to OSU teaching and research programs. Areas of expertise commonly involved in such efforts include nuclear engineering, nuclear and radiation chemistry, neutron activation analysis, radiation effects on biological systems, radiation dosimetry, environmental radioactivity, production of short-lived radioisotopes, radiation shielding, nuclear instrumentation, emergency response, transportation of radioactive materials, instrument calibration, radiation health physics, radioactive waste disposal, and other related areas.

In addition to formal academic and research support, the Center's staff provides a wide variety of other services including public tours and instructional programs, and professional consultation associated with the feasibility, design, safety, and execution of experiments using radiation and radioactive materials.

E. History

A brief chronology of the key dates and events in the history of the OSU Radiation Center and the TRIGA reactor is given below:

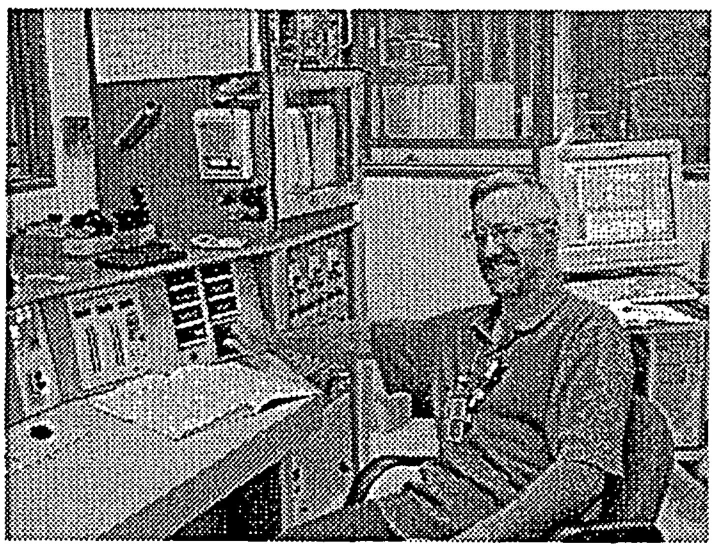
June 1964	Completion of the first phase of the Radiation Center, consisting of 32,397 square feet of office and laboratory space, under the direction of founding Director, C. H. Wang.
July 1964	Transfer of the 0.1 W AGN 201 reactor to the Radiation Center. This reactor was initially housed in the Department of Mechanical Engineering and first went critical in January, 1959.
October 1966	Completion of the second phase of the Radiation Center, consisting of 9,956 square feet of space for the TRIGA reactor and associated laboratories and offices.
March 1967	Initial criticality of the Oregon State TRIGA Reactor (OSTR). The reactor was licensed to operate at a maximum steady state power level of 250 kW and was fueled with 20% enriched fuel.
October 1967	Formal dedication of the Radiation Center.
August 1969	OSTR licensed to operate at a maximum steady state power of 1 MW, but could do so only for short periods of time due to lack of cooling capacity.
June 1971	OSTR cooling capacity upgraded to allow continuous operation at 1 MW.
April 1972	OSTR Site Certificate issued by the Oregon Energy Facility Siting Council.
September 1972	OSTR area fence installed.

December 1974	AGN-201 reactor permanently shut down.
March 1976	Completion of 1600 square feet of additional space to accommodate the rapidly expanding nuclear engineering program.
July 1976	OSTR refueled with 70% enriched FLIP fuel.
July 1977	Completion of a second 1600 square feet of space to bring the Radiation Center complex to a total of 45,553 square feet.
January 1980	Major upgrade of the electronics in the OSTR control console.
July 1980	AGN-201 reactor decommissioned and space released for unrestricted use.
June 1982	Shipment of the original 20% enriched OSTR fuel to Westinghouse Hanford Company.
December 1984	C. H. Wang retired as director. C. V. Smith became new director.
August 1986	Director C. V. Smith left to become Chancellor of the University of Wisconsin-Milwaukee. A. G. Johnson became new Director.
December 1988	AGN-201 components transferred to Idaho State University for use in their AGN-201 reactor program.
December 1989	OSTR licensed power increased to 1.1 MW.
June 1990	Installation of a 7000 Ci ^{60}Co Gammacell irradiator.
March 1992	25th anniversary of the OSTR initial criticality.
November 1992	Start of APEX plant construction.
June 1994	Retirement of Director A. G. Johnson. B. Dodd became new Director.
August 1994	APEX inauguration ceremony.
August 1995	Major external refurbishment: new roof, complete repaint, rebuilt parking lot, addition of landscaping and lighting.
September 1998	B. Dodd left on a leave of absence to the International Atomic Energy Agency. S. E. Binney became new Director.

January 1999	Installation of the Argon Production Facility in the OSTR.
April 1999	Completion of ATHRL facility brings the Radiation Center complex to a total of 47,198 square feet.
July 2002	S. E. Binney retired. J. F. Higginbotham became interim director.
October 2002	A. C. Klein became new director.

Part II

People



Part II

PEOPLE

This part contains a listing of all people who were residents of the Radiation Center or who worked a significant amount of time at the Center during this reporting period. Sections A, B, and C list the academic staff, trainees, and students, while sections D through G list the Radiation Center's operating staff. Section H provides the composition of the Reactor Operations Committee.

It should be noted that not all of the faculty and students who used the Radiation Center for their teaching and research are listed in this part. Summary information on the number of people involved is given in Table VI.C.1, while individual names and projects are listed in Tables VI.C.2 and VI.C.3.

A. Professional and Research Faculty

*Binney, Stephen E.
Director Emeritus, Radiation Center
Professor Emeritus
Nuclear Engineering and Radiation Health Physics

*Conrady, Michael R.
Faculty Research Assistant
Analytical Support Manager
Radiation Center

Craig, A. Morrie
Professor
College of Veterinary Medicine

Daniels, Malcolm
Professor Emeritus
Chemistry

Duringer, Jennifer
Research Associate
College of Veterinary Medicine

Fleischmann, Tom
Research Associate
College of Veterinary Medicine

* OSTR users for research and/or teaching.

Groome, John T.
Faculty Research Assistant
ATHRL Facility Operations Manager
Nuclear Engineering and Radiation Health Physics

*Hamby, David
Professor
Nuclear Engineering and Radiation Health Physics

Hart, Lucas P.
Faculty Research Associate
Chemistry

*Higginbotham, Jack F.
Oregon Space Grant Director
Professor
Nuclear Engineering and Radiation Health Physics

*Higley, Kathryn A.
Associate Professor
Nuclear Engineering and Radiation Health Physics

Hopson, John
ATHRL DAS Coordinator/Test Engineer
Nuclear Engineering and Radiation Health Physics

Johnson, Arthur G.
Director Emeritus, Radiation Center
Professor Emeritus
Nuclear Engineering and Radiation Health Physics

Klein, Andrew C.
Director, Radiation Center
Department Head, Department of Nuclear Engineering and Radiation Health Physics
Professor
Nuclear Engineering and Radiation Health Physics

*Krane, Kenneth S.
Professor
Physics

* OSTR users for research and/or teaching.

Lafi, Abd Y.
Assistant Professor Senior Research
(Courtesy Appointment)
ATHRL Research Analyst
Nuclear Engineering and Radiation Health Physics

*Loveland, Walter D.
Professor
Chemistry

*Menn, Scott A.
Senior Health Physicist
Radiation Center

*Palmer, Todd S.
Associate Professor
Nuclear Engineering and Radiation Health Physics

*Paulenova, Alena
Assistant Professor Senior Research
Radiation Center

Popovich, Milosh
Vice President Emeritus
Oregon State University

*Reese, Steven R.
Reactor Administrator
Radiation Center

Reyes, Jr., José N.
ATHRL Principal Investigator
Professor
Nuclear Engineering and Radiation Health Physics

Ringle, John C.
Professor Emeritus
Nuclear Engineering and Radiation Health Physics

Robinson, Alan H.
Department Head Emeritus
Nuclear Engineering and Radiation Health Physics

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* OSTR users for research and/or teaching.

*Schmitt, Roman A.
Professor Emeritus
Chemistry

*Schütfort, Erwin G.
Faculty Research Assistant
Radiation Center

*Wachs, Gary
Reactor Supervisor
Radiation Center

Wang, Chih H.
Director Emeritus, Radiation Center
Professor Emeritus
Nuclear Engineering and Radiation Health Physics

Walker, Karen
Research Assistant
College of Veterinary Medicine

Woods, Brian
Assistant Professor
Nuclear Engineering and Radiation Health Physics

Wu, Qiao
Associate Professor
Nuclear Engineer and Radiation Health Physics

Young, Roy A.
Professor Emeritus
Botany and Plant Pathology

* OSTR users for research and/or teaching.

B. Visiting Scientists and Special Trainees

Name	*Field (Affiliation)*	*Advisor or Research Program Director*
Hager, Werner Casperson	Undergraduate Research Trainees	K. S. Krane
Petersen, Gustav	Visiting Undergraduate Research Trainee, Chalmers University of Technology	W. D. Loveland
Anderson, Scott Brookhyser, James Evanson, Zach Mirpourian, Zahra Phan, Thanh	Undergraduate Research Trainees	W. D. Loveland
Nelson, Sarah Zielinski, Peter	Visiting Scientists, Lawrence Berkeley Laboratory	W. D. Loveland
Peterson, Don	Postdoctoral Assistant, Chemistry	W. D. Loveland

C. OSU Graduate Students

Name	*Degree Program*	*Field*	*Advisor*
Abel, Kent	PhD	Nuclear Engineering	J. N. Reyes
Ashbaker, Eric	MS	Radiation Health Physics	S. R. Reese
Bak, Alissa	MS	Radiation Health Physics	K. A. Higley
Davidson, Gregory	MS	Nuclear Engineering	T. S. Palmer
Davis, Ian	PhD	Nuclear Engineering	T. S. Palmer
Frey, Wesley	MS	Radiation Health Physics	J. F. Higginbotham
Gambone, Cindy	MS	Nuclear Engineering	T. S. Palmer & S. R. Reese
Huang, Zhongliang	PhD	Nuclear Chemistry	W. D. Loveland
Jones, Quyen	MS	Radiation Health Physics	D.M. Hamby
Keller, S. Todd	MS	Nuclear Engineering	T. S. Palmer
Kim, Dong W.	PHD	Nuclear Engineering	Q. Wu
Kriss, Aaron	PhD	Radiation Health Physics	D. M. Hamby
Livingston, James V.	PhD	Nuclear Engineering	T. S. Palmer
Mallory, Stacy	MS	Radiation Health Physics	D. M. Hamby

* OSTR users for research and/or teaching.

Misner, Alex	MS	Nuclear Engineering	K. A. Higley and D. M. Hamby
Naik, Radhika	PhD	Nuclear Chemistry	W. D. Loveland
Napier, Bruce	PhD	Radiation Health Physics	D. M. Hamby
Nes, Razvan	PhD	Nuclear Engineering	T. S. Palmer
Rajan, Ajith	MS	Radiation Health Physics	D. M. Hamby
Rezvyi, Aleksey	PhD	Nuclear Engineering	J. N. Reyes
Sabharwall, Piyush	MS	Nuclear Engineering	Q. Wu
Slauson, Marjorie	MS	Radiation Health Physics	K. A. Higley
Smith, Angela	MS	Radiation Health Physics	K. A. Higley
Sprunger, Peter	PhD	Physics	W. D. Loveland
Sriprisan, Sirikul	MS	Nuclear Engineering	T. S. Palmer
Staples, Christopher	MS	Physics	K. Krane
Stewart, H. Michael Jr.	MS	Radiation Health Physics	D. M. Hamby
Tavakoli, Farsoni	PhD	Radiation Health Physics	D. M. Hamby
Yao, You	PhD	Nuclear Engineering	Q. Wu
Yoo, Yeon-Jong	PhD	Nuclear Engineering	J. N. Reyes
Young, Eric	MS	Nuclear Engineering	J. N. Reyes

D. Business, Administrative and Clerical Staff

Director, Radiation Center .... A. C. Klein
Business Manager, Radiation Center and
Nuclear Engineering and Radiation Health Physics .... S. C. Campbell
Administrative Assistant, Radiation Center and
Nuclear Engineering and Radiation Health Physics .... R. A. Keen
Custodian .... E. Cimbri
Office Specialist, Radiation Center and
Nuclear Engineering and Radiation Health Physics through 9/5/03 S.M. Brumbach
Office Specialist, ATHRL–Nuclear Engineering and Radiation Health Physics T.L. Culver
Office Specialist, Nuclear Engineering and Radiation Health Physics ...... J. M. Stueve
Office Specialist, Media and Communications Assistant .... J.M. Dolan
Office Specialist, Radiation Center .... L. Mauer

E. Reactor Operations Staff

Principal Security Officer .... A. C. Klein
Reactor Administrator .... S. R. Reese
Reactor Supervisor, Senior Reactor Operator .... G. M. Wachs
Senior Reactor Operator .... S. P. Smith
S. T. Keller

F. Radiation Protection Staff

Senior Health Physicist	S. A. Menn
Health Physicist	J. E. Darrough
Health Physics Monitors (Students)	A. Gee
	A. Hamilton
	J. Juarez
	S. Kleeb

G. Scientific Support Staff

Analytical Support Manager	M. R. Conrady
Neutron Activation Analysis Technicians (Students)	K. Gray
Nuclear Instrumentation Support	M. M. Conrady
Projects Manager	E. G. Schütfort
Radiochemistry Research Coordinator	A. Paulenova
Scientific Instrument Technician	S. P. Smith

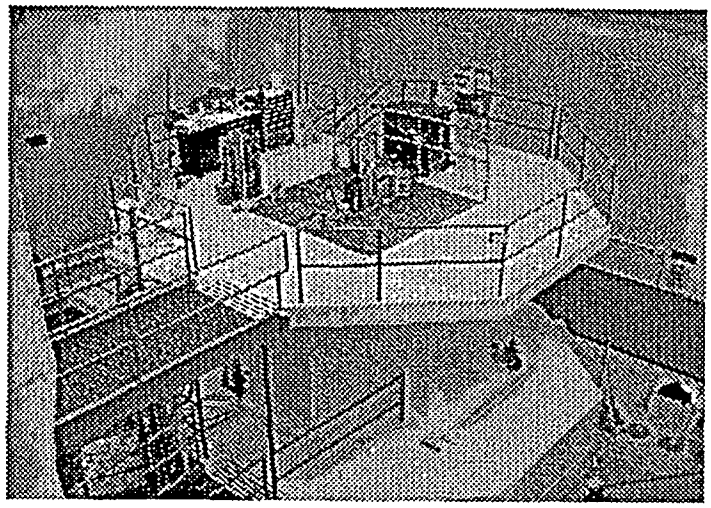
H. Committees

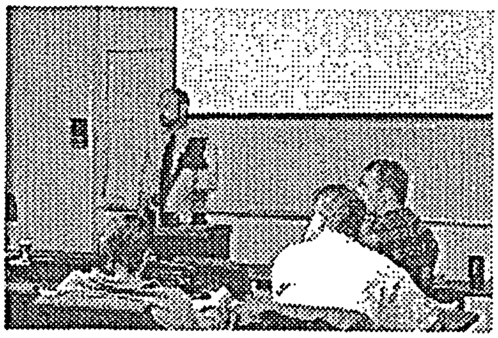
1. Reactor Operations Committee

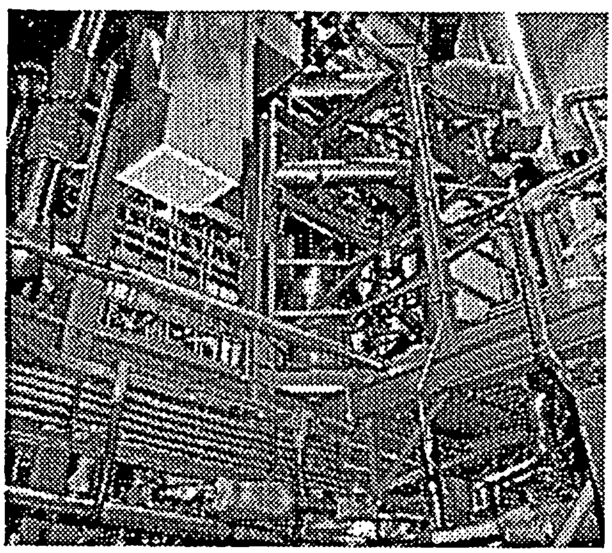
Name	*Affiliation*
J.C. Ringle, Chair	Nuclear Engineering and Radiation Health Physics
S. E. Binney	Nuclear Engineering and Radiation Health Physics
R. Busch	Mechanical Engineering
R. H. Farmer	Radiation Safety Office
D. M. Hamby	Nuclear Engineering and Radiation Health Physics
A. C. Klein	Radiation Center and Nuclear Engineering and Radiation Health Physics
S. A. Menn	Radiation Center
T. S. Palmer	Nuclear Engineering and Radiation Health Physics
W. J. Richards	McClellan Nuclear Radiation Center/NIST
S. R. Reese	Radiation Center
A. Von Jouanne	Electrical and Computer Engineering
G. M. Wachs	Radiation Center

Part III

Facilities







Part III

FACILITIES

A. Research Reactor

1. Description

The Oregon State University TRIGA Reactor (OSTR) is a water-cooled, swimming pool type of research reactor which uses uranium/zirconium hydride fuel elements in a circular grid array. The reactor core is surrounded by a ring of graphite which serves to reflect neutrons back into the core. The core is situated near the bottom of a 22-foot deep water-filled tank, and the tank is surrounded by a concrete bioshield which acts as a radiation shield and structural support.

The reactor is licensed by the U.S. Nuclear Regulatory Commission to operate at a maximum steady state power of 1.1 MW and can also be pulsed up to a peak power of about 2500 MW.

The OSTR has a number of different irradiation facilities including a pneumatic transfer tube, a rotating rack, a thermal column, four beam ports, five sample holding (dummy) fuel elements for special in-core irradiations, an in-core irradiation tube, and a cadmium-lined in-core irradiation tube for experiments requiring a high energy neutron flux. The OSTR also has an Argon Irradiation Facility for the production of ^{41}Ar.

The **pneumatic transfer facility** enables samples to be inserted and removed from the core in four to five seconds. Consequently this facility is normally used for neutron activation analysis involving short-lived radionuclides. On the other hand, the **rotating rack** is used for much longer irradiation of samples (e.g., hours). The rack consists of a circular array of 40 tubular positions, each of which can hold two sample tubes. Rotation of the rack ensures that each sample will receive an identical irradiation.

The reactor's **thermal column** consists of a large stack of graphite blocks which slows down neutrons from the reactor core in order to increase thermal neutron activation of samples. Over 99% of the neutrons in the thermal column are thermal neutrons. Graphite blocks are removed from the thermal column to enable samples to be positioned inside for irradiation.

The **beam ports** are tubular penetrations in the reactor's main concrete shield which enable neutron and gamma radiation to stream from the core when a beam port's shield plugs are removed. One of the beam ports contains the **Argon Production Facility** for production of curie levels of ^{41}Ar. The other beam ports are available for a variety of experiments.

If samples which are to be irradiated require a large neutron fluence, especially from higher energy neutrons, they may be inserted into a **dummy fuel element**. This device will then be placed into one of the core's inner grid positions which would normally be occupied by a fuel element. Similarly samples can be placed in the **in-core irradiation tube (ICIT)** which can be inserted in the same core location.

The **cadmium-lined in-core irradiation tube (CLICIT)** enables samples to be irradiated in a high flux region near the center of the core. The cadmium lining in the facility eliminates thermal neutrons and thus permits sample exposure to higher energy neutrons only. The cadmium-lined end of this air-filled aluminum irradiation tube is inserted into an inner grid position of the reactor core which would normally be occupied by a fuel element. It is the same as the ICIT except for the presence of the cadmium lining.

2. Utilization

The two main uses of the OSTR are instruction and research.

a. Instruction

Instructional use of the reactor is twofold. First, it is used significantly for classes in Nuclear Engineering, Radiation Health Physics, and Chemistry at both the graduate and undergraduate levels to demonstrate numerous principles which have been presented in the classroom. Basic neutron behavior is the same in small reactors as it is in large power reactors, and many demonstrations and instructional experiments can be performed using the OSTR which cannot be carried out with a commercial power reactor. Shorter-term demonstration experiments are also performed for many undergraduate students in Physics, Chemistry, and Biology classes, as well as for visitors from other universities and colleges, from high schools, and from public groups.

The second instructional application of the OSTR involves education of reactor operators, operations managers, and health physicists. The OSTR is in a unique position to provide such education since curricula must include hands-on experience at an operating reactor and in associated laboratories. The many types of educational programs that the Radiation Center provides are more fully described in Part VI of this report.

During this reporting period the OSTR accommodated a number of different OSU academic classes and other academic programs. In addition, portions of classes from other Oregon universities were also supported by the OSTR. Table III.D.1, provides detailed information on the use of the OSTR for instruction and training.

b. Research

The OSTR is a unique and valuable tool for a wide variety of research applications and serves as an excellent source of neutrons and/or gamma radiation. The most commonly used experimental technique requiring reactor use is instrumental neutron activation analysis (INAA). This is a particularly sensitive method of elemental analysis which is described in more detail in Part VI.

The OSTR's irradiation facilities provide a wide range of neutron flux levels and neutron flux qualities which are sufficient to meet the needs of most researchers. This is true not only for INAA, but also for other experimental purposes such as the $^{39}Ar/^{40}Ar$ ratio and fission track methods of age dating samples.

B. Analytical Equipment

1. Description

The Radiation Center has a large variety of radiation detection instrumentation. This equipment is upgraded as necessary, especially the gamma ray spectrometers with their associated computers and germanium detectors. Additional equipment for classroom use and an extensive inventory of portable radiation detection instrumentation are also available.

2. Utilization

Radiation Center nuclear instrumentation receives intensive use in both teaching and research applications. In addition, service projects also use these systems and the combined use often results in 24-hour per day schedules for many of the analytical instruments. Use of Radiation Center equipment extends beyond that located at the Center and instrumentation may be made available on a loan basis to OSU researchers in other departments.

C. Radioisotope Irradiation Sources

1. Description

The Radiation Center is equipped with a 1,644 curie (as of 7/27/01) Gammacell 220 ^{60}Co irradiator which is capable of delivering high doses of gamma radiation over a range of dose rates to a variety of materials.

Typically, the irradiator is used by researchers wishing to perform mutation and other biological effects studies; studies in the area of radiation chemistry; dosimeter testing; sterilization of food materials, soils, sediments, biological specimen, and other media; gamma radiation damage studies; and other such applications. In addition to the ^{60}Co irradiator, the Center is also equipped with a variety of smaller ^{60}Co, ^{137}Cs, ^{226}Ra, plutonium-beryllium, and other isotopic sealed sources of various radioactivity levels which are available for use as irradiation sources.

2. Utilization

During this reporting period there was a diverse group of projects using the ^{60}Co irradiator. These projects included the irradiation of a variety of biological materials including different types of seeds. In addition, the irradiator was used for sterilization of several media and the evaluation of the radiation effects on different materials. Table III.C.1 provides use data for the Gammacell 220 irradiator.

D. Laboratories and Classrooms

1. Description

The Radiation Center is equipped with a number of different radioactive material laboratories designed to accommodate research projects and classes offered by various OSU academic departments or off-campus groups.

Instructional facilities available at the Center include a laboratory especially equipped for teaching radiochemistry and a nuclear instrumentation teaching laboratory equipped with modular sets of counting equipment which can be configured to accommodate a variety of experiments involving the measurement of many types of radiation. The Center also has four student computer rooms equipped with a large number of personal computers and UNIX workstations.

In addition to these dedicated instructional facilities, many other research laboratories and pieces of specialized equipment are regularly used for teaching. In particular, classes are routinely given access to gamma spectrometry equipment located in Center laboratories. A number of classes also regularly use the OSTR and the Reactor Bay as an integral part of their instructional coursework.

There are two classrooms in the Radiation Center which are capable of holding about 35 and 18 students, respectively. In addition, there are two smaller conference rooms and a library that are suitable for graduate classes and thesis examinations. As a service to the student body, the Radiation Center also provides an office area for the student chapters of the American Nuclear Society and the Health Physics Society.

This reporting period saw continued high utilization of the Radiation Center's thermal hydraulics laboratory. This laboratory is being used by Nuclear Engineering faculty member to accommodate a one-quarter scale model of the Palisades Nuclear Power reactor. The multi-million dollar advanced plant experimental (APEX) facility was fully utilized by the U. S. Nuclear Regulatory Commission to provide licensing data and to test safety systems in "beyond design basis" accidents. The fully scaled, integral model APEX facility uses electrical heating elements to simulate the fuel elements, operates at 450°F and 400 psia, and responds at twice real time. It is the *only* facility of its type in the world and is owned by the U. S. Department of Energy and operated by OSU. In addition, a new building, the Air-water Test Loop for Advanced Thermal-hydraulics Studies (ATLATS), was constructed next to the Reactor Building in 1998. Two-phase flow experiments are conducted in the ATLATS. Together APEX and ATLATS comprise the Advanced Thermal Hydraulics Research Laboratory (ATHRL).

2. Utilization

All of the laboratories and classrooms are used extensively during the academic year. For example, a listing of courses accommodated at the Radiation Center during this reporting period along with their enrollments is given in Table III.D.1.

E. Instrument Repair and Calibration Facility

1. Description

The Radiation Center has a facility for the repair and calibration of essentially all types of radiation monitoring instrumentation. This includes instruments for the detection and measurement of alpha, beta, gamma, and neutron radiation. It encompasses both high range instruments for measuring intense radiation fields and low range instruments used to measure environmental levels of radioactivity.

2. Utilization

The Center's instrument repair and calibration facility is used regularly throughout the year and is absolutely essential to the continued operation of the many different programs carried out at the Center. In addition, the absence of any comparable facility in the state has led to a greatly expanded instrument calibration program for the Center, including *calibration of essentially all radiation detection instruments used by state and federal agencies in the state of Oregon.* This includes instruments used on the OSU campus and all other institutions in the Oregon University System, plus instruments from the Oregon Health Division's Radiation Protection Services, the Oregon Department of Energy, the Oregon Public Utilities Commission, the Oregon Health Sciences University, the Army Corps of Engineers, and the U. S. Environmental Protection Agency.

F. Library

1. Description

The Radiation Center has a library containing significant collections of texts, research reports, and videotapes relating to nuclear science, nuclear engineering, and radiation protection.

The Radiation Center is also a regular recipient of a great variety of publications from commercial publishers in the nuclear field, from many of the professional nuclear societies, from the U. S. Department of Energy, the U. S. Nuclear Regulatory Commission, and other federal agencies. Therefore, the Center library maintains a current collection of leading nuclear research and regulatory documentation. In addition, the Center has a collection of a number of nuclear power reactor Safety Analysis Reports and Environmental Reports specifically prepared by utilities for their facilities.

The Center maintains an up-to-date set of reports from such organizations as the International Commission on Radiological Protection, the National Council on Radiation Protection and Measurements, and the International Commission on Radiological Units. Sets of the current U.S. Code of Federal Regulations for the U.S. Nuclear Regulatory Commission, the U.S. Department of Transportation, and other appropriate federal agencies, plus regulations of various state regulatory agencies are also available at the Center.

The Radiation Center videotape library has over one hundred tapes on nuclear engineering, radiation protection, and radiological emergency response topics. In addition, the Radiation Center uses videotapes for most of the technical orientations which are required for personnel working with radiation and radioactive materials. These tapes are produced, recorded, and edited by Radiation Center staff, using the Center's videotape equipment and the facilities of the OSU Communication Media Center.

2. Utilization

The Radiation Center library is used mainly to provide reference material on an as-needed basis. It receives extensive use during the academic year. In addition, the orientation videotapes are used intensively during the beginning of each term and periodically thereafter.

Table III.C.1

Gammacell 220 ^{60}Co Irradiator Use
(1276 Ci: 7/1/03)

Purpose of Irradiation	Samples	Dose Range (rads)	Number of Irradiations	Use Time (hours)
Sterilization	wood, stents, sponges, soil, biological sample, bioflex strips,	2.0×10^4 to 4.0×10^6	33	990
Biological Studies	anticancer vaccine	2.0×10^2 to 1.0×10^3	39	0
Botanical Studies	pollen, bean seeds	5.0×10^3 to 8.0×10^4	21	5
Material Evaluation	electronic components, minerals	6.0×10^6 to 6.0×10^6	1	97
Other	biological sample	2.0×10^4 to 2.0×10^4	2	0
TOTALS			96	1,092

Table III.D.1

Student Enrollment in Nuclear Engineering, Radiation Health Physics and Nuclear Science Courses Which Are Taught or Partially Taught at the Radiation Center

Course	Credit	Course Title	Number of Students			
			Summer 2003	Fall 2004	Winter 2004	Spring 2003
Nuclear Engineering and Radiation Health Physics Department Courses						
NE/RHP114*	2	Introduction to Nuclear Engineering and Radiation Health Physics	-	25	–	–
NE/RHP115	2	Introduction to Nuclear Engineering and Radiation Health Physics	–	–	27	–
NE/RHP116*	2	Introduction to Nuclear Engineering and Radiation Health Physics	–	–	–	24
NE/RHP234	4	Nuclear and Radiation Physics I	–	32	–	–
NE/RHP235	4	Nuclear and Radiation Physics II	–	–	32	–
NE/RHP236*	4	Nuclear Radiation Detection and Instrumentation	–	–	–	32
NE319	3	Societal Aspects of Nuclear Technology	–	–	66	–
NE/RHP401	1-16	Research	–	1	–	–
NE405H	1-16	R&C/Used Nuclear Fuel: Garbage or Gold	–	–	–	–
NE405	1-16	Reading and Conference	–	–	–	–
RHP405	1-16	Reading and Conference	–	11	–	–
NE/RHP406	1-16	Projects	10	1	1	10
NE/RHP407	1	Nuclear Engineering Seminar	—	26	17	18
NE/RHP410	1-12	Internship	2	1	3	2
NE/RHP415	2	Nuclear Rules and Regulations	–	–	–	–
NE416**	4	Radiochemistry	–	2	–	–
NE450	3	ST/ Nuclear Medicine	–	–	–	–
NE451**	4	Neutronic Analysis and Lab I	–	27	–	–
NE452**	4	Neutronic Analysis and Lab II	–	–	28	–
NE453**	4	Neutronic Analysis and Lab III	–	–	–	–

ST = Special Topics
* = OSTR used occasionally for demonstration and/or experiments.
** = OSTR used heavily.

Table III.D.1 (continued)

Student Enrollment in Nuclear Engineering, Radiation Health Physics and Nuclear Science Courses Which Are Taught or Partially Taught at the Radiation Center

NE457**	3	Nuclear Reactor Laboratory	–	–	–	–
NE467	4	Nuclear Reactor Thermal Hydraulics	–	13	–	–
NE474	4	Nuclear Systems Design I	–	–	15	–
NE475	4	Nuclear Systems Design II	–	–	–	15
NE/RHP479	1-4	Individual Design Project	–	1	–	–
NE/RHP481	4	Radiation Protection	–	22	–	–
NE/RHP482*	4	Applied Radiation Safety	–	–	35	–
RHP483	4	Radiation Biology	–	–	–	–
RHP487	3	Radiation Biology	–	–	–	–
RHP488	3	Radioecology	–	–	–	–
NE/RHP490	4	Radiation Dosimetry	–	–	–	26
RHP493	3	Non-reactor Radiation Protection	–	–	–	–
NE/RHP499	1-16	St/Environmental Aspects Nuclear Systems	–	–	–	–
NE/RHP501	1-16	Research	1	1	–	–
NE/RHP503	1	Thesis	–	–	–	–
NE/RHP505	1-16	Reading and Conference	–	–	–	2
NE/RHP506	1-16	Projects	–	–	–	–
NE/RHP507/607	1	Nuclear Engineering Seminar	–	17	16	15
NE/RHP510	1-12	Internship	–	–	1	1
NE/RHP515	2	Nuclear Rules and Regulations	–	–	–	–
NE526	3	Computational Methods for Nuclear Reactors	–	–	2	–
NE/RHP535	3	Nuclear Radiation Shielding	–	–	–	17
NE/RHP539	3	ST/Nuclear Physics for Engineers and Scientists	–	–	8	–

ST = Special Topics
* = OSTR used occasionally for demonstration and/or experiments.
** = OSTR used heavily.

Table III.D.1 (continued)

Student Enrollment in Nuclear Engineering, Radiation Health Physics and Nuclear Science Courses Which Are Taught or Partially Taught at the Radiation Center

NE/RHP543	3	Hi-Level Radioactive Waste Management	–	–	–	–
NE/RHP549	3	Low Level Waste	–	–	–	–
NE550	3	Nuclear Medicine	–	–	–	–
NE551**	4	Neutronic Analysis and Lab I	–	7	–	–
NE552**	4	Neutronic Analysis and Lab II	–	–	6	–
NE553**	4	Neutronic Analysis and Lab III	–	–	–	9
NE557**	3	Nuclear Reactor Laboratory	–	–	–	–
NE559	1	ST/Nuclear Reactor Analysis: Criticality Safety	–	6	–	–
NE567	4	Advanced Nuclear Reactor Thermal Hydraulics	–	6	–	–
NE568	3	Nuclear Reactor Safety	–	–	–	–
NE569	1-3	ST/Thermal Hydraulic Instumentation	–	–	–	1
NE574	4	Nuclear Systems Design I	–	–	5	–
NE575	4	Nuclear Systems Design II	–	–	–	5
NE/RHP581	4	Radiation Protection	–	11	–	–
NE /RHP582*	4	Applied Radiation Safety	–	–	8	–
RHP583	4	Radiation Biology	–	6	–	–
NE585	3	Environmental Aspects Nuclear Systems	–	–	–	–
RHP585	3	Environmental Aspects Nuclear Systems	–	–	–	–
NE/RHP586	3	Advanced Radiation Dosimetry	–	–	–	–
RHP588	3	Radioecology	–	–	–	–
RHP589	1-3	ST/Radiation Protection and Risk Assessment	–	–	–	–
RHP593	3	Non-Reactor Radiation Protection	–	–	–	–
NE599	1	ST/Principles of Nuclear Medicine	–	–	–	–

ST = Special Topics
* = OSTR used occasionally for demonstration and/or experiments.
** = OSTR used heavily.

Table III.D.1 (continued)

Student Enrollment in Nuclear Engineering, Radiation Health Physics and Nuclear Science Courses Which Are Taught or Partially Taught at the Radiation Center

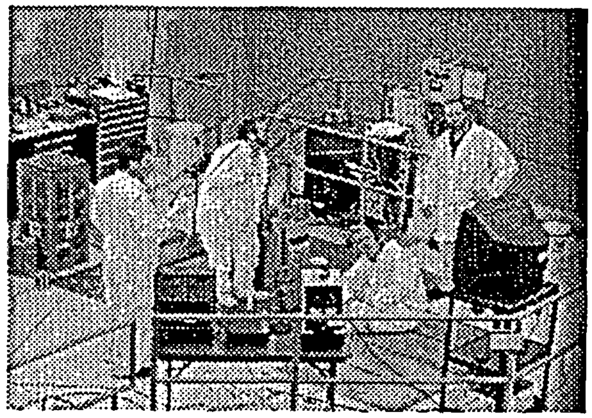
NE/RHP601	1-16	Research	–	1	1	1
NE/RHP603	1-16	Thesis	2	—	—	–
NE/RHP605	1-16	Reading and Conference	2	2	2	2
RHP610	1-12	Internship	–	–	–	–
NE654	3	Neutron Transport Theory	–	–	5	–
NE667	3	Advanced Thermal Hydraulics	–	–	–	–
Courses from Other Departments						
CH123*		General Chemistry	–		–	229
CH222*	5	General Chemistry (Science Majors)	--	--	268	--
CH225H	5	Honors General Chemistry	--	--	43	--
CH462*	3	Experimental Chemistry II Laboratory	--	--	11	--
ENGR331	4	Momentum, Energy and Mass	--	–	96	–
GEO300	3	Environmental Conservation	–	132	–	–
PH202	5	General Physics	–	—	217	–
Courses from Other Institutions						
GS105*	LBCC	General Science	—	–	35	–

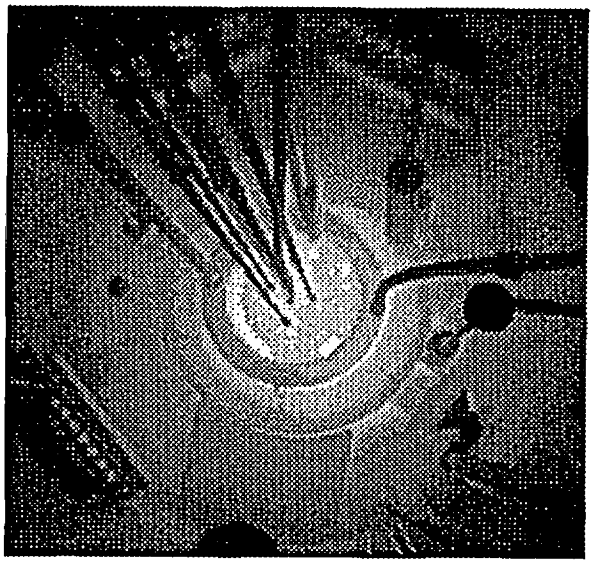
NOTE:
This table does not include the thesis courses from other OSU departments (see Table VI.C.2).

ST = Special Topics
* = OSTR used occasionally for demonstration and/or experiments.
** = OSTR used heavily.

Part IV

Reactor





Part IV

REACTOR

A. Operating Status

Reactor power generation for the operating period between July 1, 2003 and June 30, 2004 totaled 966 kWH of thermal power. This is equal to 40.2 megawatt days of generation, and results in a cumulative thermal energy output by the OSTR FLIP core of 1068 MWD from August 1976 through June 30, 2004.

The Oregon State TRIGA Reactor (OSTR) operated with some interruptions during the 2003/4 reporting period. Reactor operations were suspended for a total of 5 days due to equipment failures and an abnormal core configuration created by the removal of a fuel element in preparation for control rod calibrations. An additional 43 operating days were lost due to the construction of the neutron radiography facility adjacent to Beam Port #3

The productivity of the reactor irradiation facilities is based on reactor operation in relation to use categories. Greater productivity is achieved by utilizing greater numbers of irradiation facilities at the same time. Tables IV.A.3 through 5 provide this years detail on reactor use and other tracked data.

A normal nine-hour, five-day per week schedule sets the total available reactor operating hours. Critical reactor operation averaged 45.3% of each day. Of the 2160 total available annual operating hours, 977 hours were at power, 458 hours were spent conducting facility startup and shutdown operations, 614 hours were expended for maintenance and sample decay delays and 111 hours the reactor was not operating for reasons other than listed above.

Table IV.A.1 provides information related to the OSTR annual energy production, fuel usage and use requests. Table IV.A.2 summarizes statistics for the original 20% enriched fuel loading.

B. Experiments Performed

1. Approved Experiments

During the current reporting period there were nine approved reactor experiments available for use in reactor-related programs. These are listed below.

A-1 Normal TRIGA Operation (No Sample Irradiation).

B-3 Irradiation of Materials in the Standard OSTR Irradiation Facilities.
B-11 Irradiation of Materials Involving Specific Quantities of Uranium and Thorium in the Standard OSTR Irradiation Facilities.
B-12 Exploratory Experiments.
B-23 Studies Using TRIGA Thermal Column.
B-29 Reactivity Worth of Fuel.
B-31 TRIGA Flux Mapping.
B-32 Argon Production Facility.
B-33 Irradiation of Combustible Liquids in Rotating Rack.

Of these available experiments, three were used during the reporting period. Table IV.B.1 provides information related to the frequency of use and the general purpose of their use.

2. Inactive Experiments

Presently 32 experiments are in the inactive file. This consists of experiments which have been performed in the past and may be reactivated. Many of these experiments are now performed under the more general experiments listed in the previous section. The following list identifies these 32 inactive experiments.

A-2 Measurement of Reactor Power Level via Mn Activation.
A-3 Measurement of Cd Ratios for Mn, In, and Au in Rotating Rack.
A-4 Neutron Flux Measurements in TRIGA.
A-5 Copper Wire Irradiation.
A-6 In-core Irradiation of LiF Crystals.
A-7 Investigation of TRIGA's Reactor Bath Water Temperature Coefficient and High Power Level Power Fluctuation.
B-1 Activation Analysis of Stone Meteorites, Other Meteorites, and Terrestrial Rocks.
B-2 Measurements of Cd Ratios of Mn, In, and Au in Thermal Column.
B-4 Flux Mapping.
B-5 In-core Irradiation of Foils for Neutron Spectral Measurements.
B-6 Measurements of Neutron Spectra in External Irradiation Facilities.
B-7 Measurements of Gamma Doses in External Irradiation Facilities.
B-8 Isotope Production.
B-9 Neutron Radiography.
B-10 Neutron Diffraction.
B-13 This experiment number was changed to A-7.
B-14 Detection of Chemically Bound Neutrons.
B-15 This experiment number was changed to C-1.
B-16 Production and Preparation of ^{18}F.
B-17 Fission Fragment Gamma Ray Angular Correlations.
B-18 A Study of Delayed Status (n, γ) Produced Nuclei.
B-19 Instrument Timing via Light Triggering.
B-20 Sinusoidal Pile Oscillator.

B-21 Beam Port #3 Neutron Radiography Facility.
B-22 Water Flow Measurements Through TRIGA Core.
B-24 General Neutron Radiography.
B-25 Neutron Flux Monitors.
B-26 Fast Neutron Spectrum Generator.
B-27 Neutron Flux Determination Adjacent to the OSTR Core.
B-28 Gamma Scan of Sodium (TED) Capsule.
B-30 NAA of Jet, Diesel, and Furnace Fuels.
C-1 PuO_2 Transient Experiment.

C. Unplanned Shutdowns

There were seven unplanned reactor shutdowns during the current reporting period. A scram occurs when the control rods drop in as a result of an automatic trip or as a result of the operator pushing the manual trip button. Due to unusual conditions or operational anomalies of a less critical nature, the reactor may also be secured by manual rod insertion. Table IV.C.1 contains a summary of the unplanned scrams, including a brief description of the cause of each.

D. Changes to the OSTR Facility, to Reactor Procedures, and to Reactor Experiments Performed Pursuant to 10 CFR 50.59

The information contained in this section of the report provides a summary of the changes performed during the reporting period under the provisions of 10 CFR 50.59. For each item listed, there is a brief description of the action taken and a summary of the applicable safety evaluation.

1. 10 CFR 50.59 Changes to the Reactor Facility

There were six changes to the reactor facility during this reporting period. For additional information regarding these changes, or copies of the changes, contact the OSTR Operations staff.

(1) *03-03, Removal of Existing Beam Port #3 Radiography Blockhouse*

(a) Description

The interim concrete block shield structure, constructed to test the beam quality and thermal neutron flux within Beam Port #3 was removed following the completion of testing and evaluation. All components of the original BP were returned to their original configuration.

(b) Safety Evaluation

Restoration of the beam port and its internal components returned the facility to its original approved configuration.

(2) *04-04, Beam Port #3 Collimator*

(a) Description

In preparation for construction of the permanent Beam Port #3 shield blockhouse, a neutron beam collimator was installed in BP3 in place of the original concrete and wood shield plugs. Additional lead and concrete blocks were placed in front of the collimator to ensure dose rates were minimized. Reactor operations were suspended during the construction phase of the shield blockhouse.

(b) Safety Evaluation

The collimator placed within the BP3 tube is external to the reactor and performs a passive function. The reduction of shielding capablity from the original components was offset by maintaining reactor power at shutdown levels and the use of temporary shielding materials.

(3) *04-05, Interim Configuration of the Neutron Radiography Facility (NRF)*

(a) Description

An operating configuration was placed in effect which ensured that the newly constructed NRF adjacent to Beam Port #3 would provide adequate radiological shielding during full power reactor operations prior to full installation of the proposed NRF access interlock and control system. A mechanical, air operated shield shutter is in place3 in front of the Beam Port #3 collimater inside the NRF structure. Mechanically blocking the shutter in the closed position, securing operating air and alarming the NRF doors effectively restricts access to any potential high radiation areas during the period of reactor operations.

Area radiation mnonitors relocation and an at power radiation survey verify that existing radiation levels are maintained at acceptable levels adjacent to the NRF.

(b) Safety Analysis

This configuration change maintains adequate radiological protection in the absence of an installed and operating automatic interlock and control system. The only interface with reactor systems will be through the use of plant annunciators, attached to door micro switches, indicating possible access to the inside of the NRF.

(4) *03-07, Replacement of the Primary Tank water Level Indication System*

(a) Description

The current reactor tank water level detection system has been replaced with an electronic level sensing system. The old Styrofoam float and microswitch system was removed. In its place, two LED/Phototransistor probes are used to detect reactor tank water level. Both high and low water levels continue to be annunciated in the control room. The monthly testing of the level proves makes an annual system test redundant.

(b) Safety Analysis

Since the system circuitry is normally energized, failure of the system results in an alarm condition. Mechanical binding of the old type floats is eliminated.

(5) *03-8, Installation of an In-Coire Irradiation Tube Storage Rack*

(a) Description

An in-core rack specifically designed to hold the three in-core irradiation tubes, which were developed to expand sample irradiation capabilities, was installed in the reactor tank. This rack, designated as the "T" rack is configured to hold the three long irradiation tubes in an advantageous position minimizing the need for creative attachment methods.

(b) Safety Analysis

Concerns regarding the failure of mounting bolts allowing the rack to lodge in the control rods and interfere with their operation were assessed as being consistent with other equipment mounted to the primary tank liner. Since all tubes are slightly buoyant, minimal stress is placed on the mounting system.

(6) *03-010, Removal of Fuel Element in Grid Position F29*

(a) Description

Fuel element #8404 was removed from core position F29 and placed in a reactor tank side storage rack. This fuel removal was required to reduce excess core reactivity caused by the burn up of erbium resulting in an approach to Technical Specification limits of shutdown margin under all core configurations.

(b) Safety Analysis

Fuel element #8404 was measured as having a reactivity value of $0.23 ± $0.01. Although removal of the element is expected to result in a higher power density per element in the core, the power density will not increase above that which has already been shown to be acceptable.

2. 10 CFR 50.59 Changes to Reactor Procedures

Numerous changes to procedures related to reactor operation were prompted by facility changes and the periodic review of the Reactor Operations Committee (ROC).

For additional information regarding these changes, or copies of the changes, contact the OSTR Operations staff.

(1) *04-01, Revisions to OSTROP 18*

(a) Description

The major procedural change under this revision was to reconfigure the Irradiation Request forms to conform to comments by users and staff and to clarify form completion and data retention processes.

(b) Safety Evaluation

The intent of the procedure was not significantly altered. The changes simply made the intent of the irradiation request form clearer and more useable to experimenters.

(2) *04-07, Revisions to OSTROP 6 and 17*

(a) Description

OSTROP 6, Administrative and Personnel Procedures, reduced the number of controlled copies of the five documents deemed necessary for distribution from nine to seven. Removed the two unnecessary recipients from the distribution list.

OSTROP 17, Reactor Room Ventilation System Procedures, changes were made to clarify the location and operational steps of the reactor room ventilation system following system upgrade.

(b) Safety Evaluation

Procedural changes did not affect the intent, but rather updated the procedures to reflect current facility operations..

3. 10 CFR 50.59 Changes to Reactor Experiments

(5) *03-05, Creation of Experiment B-33*

(a) Description

A new reactor experiment was created to cover the irradiation of combustible liquids in the rotating rack irradiation facility. Although this process is similar to a previous experiment, B-30, Irradiation of Jet, Diesel and Furnace Fuels, the previous experiment was retired due to lack of usage. Also, changes in the method of encapsulation were imposed.

Several limitations were placed on the irradiation of combustible materials to minimize the oxygen present in the containment capsule, sample volume, flash point and internal pressure developed.

(b) Safety Analysis

Minimizing the potential for release of irradiated material within the rotating rack was addressed by the imposition of material limitations.

E. Surveillance and Maintenance

1. Non-Routine Maintenance

July 2003	PA system converted to provide automated evacuation alarm annunciation .
August 2003	Completed fabrication of 2n CLICIT tube.
September 2003	Fabricated and installed in-core irradiation tube storage rack ("T") rack.
November 2003	Replaced failed Stack monitor vane air pump with roots type blower.
February 2004	Replaced failed Percent Power ion chamber with space.
March 2004	Began outage for construction of Beam Port #3 neutron radiography facility (NRF)
May 2004	Restored reactor operation following completion of construction phase of the NRF.

2. Routine Surveillance and Maintenance

The OSTR has an extensive routine surveillance and maintenance (S&M) program. Examples of typical S&M checklists are presented in Figures IV.E.1 through IV.E.4. Items identified by shading are required by the OSTR Technical Specifications.

F. Reportable Occurrences

No reportable occurrences were identified during this fiscal year.

Table IV.A.1

OSTR Operating Statistics (Using the FLIP Fuel Core)

Operational Data for FLIP Core	August 1, 1976 Through June 30, 1977	July 1, 1977 Through June 30, 1978	July 1, 1978 Through June 30, 1979	July 1, 1979 Through June 30, 1980	July 1, 1980 Through June 30, 1981	July 1, 1981 Through June 30, 1982	July 1, 1982 Through June 30, 1983	July 1, 1983 Through June 30, 1984
Operating Hours (critical)	875	819	458	875	1255	1192	1095	1205
Megawatt Hours	451	496	255	571	1005	999	931	943
Megawatt Days	19.0	20.6	10.6	23.8	41.9	41.6	38.8	39.3
Grams ^{235}U Used	24.0	25.9	13.4	29.8	52.5	52.4	48.6	49.3
Hours at Full Power (1 MW)	401	481	218	552	998	973	890	929
Numbers of Fuel Elements Added or Removed (-)	85	0	2	0	0	1	0	0
Number of Irradiation Requests	44	375	329	372	348	408	396	469

Table IV.A.1 (Continued)

OSTR Operating Statistics (Using the FLIP Fuel Core)

Operational Data for FLIP Core	July 1, 1984 Through June 30, 1985	July 1, 1985 Through June 30, 1986	July 1, 1986 Through June 30, 1987	July 1, 1987 Through June 30, 1988	July 1, 1988 Through June 30, 1989	July 1, 1989 Through June 30, 1990	July 1, 1990 Through June 30, 1991	July 1, 1991 Through June 30, 1992	July 1, 1992 Through June 30, 1993
Operating Hours (critical)	1205	1208	1172	1352	1170	1136	1094	1158	1180
Megawatt Hours	946	1042	993	1001	1025	1013	928	1002	1026
Megawatt Days	39.4	43.4	41.4	41.7	42.7	42.2	38.6	41.8	42.7
Grams ^{235}U Used	49.5	54.4	51.9	52.3	53.6	53.0	48.5	52.4	53.6
Hours at Full Power (1 MW)	904	1024	980	987	1021	1009	909	992	1000
Numbers of Fuel Elements Added or Removed (-)	0	0	0	-2	0	-1,+1	-1	0	0

Table IV.A.1 (Continued)

OSTR Operating Statistics (Using the FLIP Fuel Core)

Operational Data for FLIP Core	July 1, 1993 Through June 30, 1994	July 1, 1994 Through June 30, 1995	July 1, 1995 Through June 30, 1996	July 1, 1996 Through June 30, 1997	July 1, 1997 Through June 30, 1998	July 1, 1998 Through June 30, 1999	July 1, 1999 Through June 30, 2000	July 1, 2000 Through June 30, 2001	July 1, 2001 Through June 30, 2002
Operating Hours (critical)	1248	1262	1226	1124	1029	1241	949	983	1029
Megawatt Hours	1122	1117	1105	985	927	1115	852	896	917
Megawatt Days	46.7	46.6	46.0	41.0	38.6	46.5	35.5	37.3	38.2
Grams ^{235}U Used	58.6	58.4	57.8	51.5	48.5	58.3	44.6	46.8	47.7
Hours at Full Power (1 MW)	1109	1110	1101	980	921	1109	843	890	912
Numbers of Fuel Elements Added or Removed (-)	0	0	-1[5]	-1, +[7]	0	-1[5]	0	0	-1[5]
Number of Irradiation Requests	303	324	268	282	249	231	234	210	239

Table IV. A.1 (Continued)

OSTR Operating Statistics (Using the FLIP Fuel Core)

Operational Data for FLIP Core	July 1, 2002 Through June 30, 2003	July 1, 2003 Through June 30, 2004	July 1, 2004 Through June 30, 2005	July 1, 2005 Through June 30, 2006	July 1, 2006 Through June 30, 2007	July 1, 2007 Through June 30, 2008	July 1, 2008 Through June 30, 2009	July 1, 2009 Through June 30, 2010	July 1, 2010 Through June 30, 2011
Operating Hours (critical)	1100	977							
Megawatt Hours	1025	966							
Megawatt Days	42.7	40.2							
Grams ^{235}U Used	50.5	48.0							
Hours at Full Power (1 MW)	1023	965							
Numbers of Fuel Elements Added or Removed (-)	0	-1 (5)							
Number of Irradiation Requests	215	207							

(1) The reactor was shutdown on July 26, 1976 for one month in order to completely refuel the reactor with a new FLIP fuel core.
(2) No fuel elements were added, but one fueled follower control rod was replaced.
(3) Two fuel elements were removed due to cladding deformation.
(4) One fuel element removed due to cladding deformation and one new fuel element added.
(5) One fuel element removed for core excess adjustment.
(6) No fuel elements were added, but the instrumented fuel element was replaced.
(7) One fuel element removed due to cladding deformation and one use fuel element added.

Table IV.A.2

OSTR Operating Statistics with the Original (20% Enriched) Standard TRIGA Fuel Core

Operational Data for 20% Enriched Core	Mar 8, 67 Through Jun 30, 68	Jul 1, 68 Through Jun 30, 69	Jul 1, 69 Through Mar 31, 70	Apr 1, 70 Through Mar 31, 71	Apr 1, 71 Through Mar 31, 72	Apr 1, 72 Through Mar 31, 73	Apr 1, 73 Through Mar 31, 74	Apr 1, 74 Through Mar 31, 75	Apr 1, 75 Through Mar 31, 76	Apr 1, 76 Through Jul 26, 76	TOTAL: March 67 Through July 76
Operating Hours (critical)	904	610	567	855	598	954	705	563	794	353	6903
Megawatt Hours	117.2	102.5	138.1	223.8	195.1	497.8	335.9	321.5	408.0	213.0	2553.0
Megawatt Days	4.9	4.3	5.8	9.3	8.1	20.7	14.1	13.4	17.0	9.0	106.4
Grams ^{235}U Used	6.1	5.4	7.2	11.7	10.2	26.0	17.6	16.8	21.4	10.7	133.0
Hours at Full Power (250 kW)	429	369	58	---	---	---	---	---	---	---	856
Hours at Full Power (1 MW)	---	---	20	23	100	401	200	291	460	205	1700
Number of Fuel Elements Added to Core	70 (Initial)	2	13	1	1	1	2	2	2	0	94
Number of Irradiation Requests	429	433	391	528	347	550	452	396	357	217	4100
Number of Pulses	202	236	299	102	98	249	109	183	43	39	1560

(1) Reactor went critical on March 8, 1967 (70 element core; 250kW). Note: This period length is 1.33 years as initial criticality occurred in March of 1967.

(2) Reactor shutdown August 22, 1969 for one month for upgrading to 1MW (did not upgrade cooling system). Note: This period length is only 0.75 years as there was a change in the reporting period from July-June to April-March.

(3) Reactor shutdown June 1, 1971 for one month for cooling system upgrading.

(4) Reactor shutdown July 26, 1976 for one month for refueling reactor with a new full FLIP fuel core. Note: This period length is 0.33 years.

Table IV.A.3

Present OSTR Operating Statistics

Operational Data for FLIP Core	Annual Values (2003/2004)	Cumulative Values for FLIP Core
MWH of energy produced	966	25,652
MWD of energy produced	40.2	1,068.2
Grams ^{235}U used	48.0	1,335.5
Number of fuel elements added to (+) or removed from (-) the core	-1	78 + 3 FFCR[1]
Number of pulses	17	1,384
Hours reactor critical	977	25,320
Hours at full power (1 MW)	965	25,231
Number of startup and shutdown checks	240	7,657
Number of irradiation requests processed	207	8,975
Number of samples irradiated	1,845	112,830

(1) Fuel Follower Control Rod. These numbers represent the core loading at the end of this reporting period.

Table IV.A.4

OSTR Use Time in Terms of Specific Use Categories

OSTR Use Category	Annual Values (hours)	Cumulative Values for FLIP Core (hours)
Teaching (departmental and others)(1)	16	13,192
OSU Research	411	9,783
Off-campus research	1,587	20,320
Forensic services	0	234(2)
Reactor preclude time	1146	22,712
Facility time(3)	0	7,117
TOTAL REACTOR USE TIME	3,160	73,358

(1) See Tables III.A.1 and III.D.1 for teaching statistics (reactor tours are not logged as use).

(2) Prior to the 1981-1982 reporting period, forensic services were grouped under another use category and the cumulative hours have been compiled beginning with the 1981-1982 report.

(3) The time OSTR spent operating to meet NRC facility license requirements.

Table IV.A.5

OSTR Multiple Use Time

Number of Users	Annual Values (hours)	Cumulative Values for FLIP Core (hours)
Two	515	5,448
Three	160	1,802
Four	61	637
Five	7.5	149.5
Six	0	59
Seven	0	12
TOTAL MULTIPLE USE TIME	743.5	8,107.5

Table IV.B.1

Use of OSTR Reactor Experiments

Experiment Number	Research	Teaching	Forensic	NRC License Requirement	Other	Total
A-1	2	0	0	0	0	2
B-3	183	20	0	0	0	203
B-32	2	0	0	0	0	2
Total	**187**	**20**	**0**	**0**	**0**	**207**

Table IV.C.1

Unplanned Reactor Shutdowns and Scrams

Type of Event	Number of Occurrences	Cause of Event
Safety Channel Scram	1	Operator error - operator failed to maintain steady state power below scram setpoint.
Safety Channel Scram	1	Power spike caused by withdrawal of Cd covered wire experiment from core area following short irradiation.
Safety Channel Scram	1	Operator error - operator failed to maintain power levels following increase to 1 MW after square wave to 500 kW.
Percent Power Channel Scram	1	Operator error - operator failed to maintain power during indicated power creep upwards due to pool temperature reduction.
Manual Reactor Shutdown	1	Unable to raise Shim rod reliably. Related to motor cooling or possible internal rod barrel binding. Operation restored following forced cooling of drive motor.
Manual Reactor Shutdown	1	Loss of secondary cooling pump during power escalation. Thermal overloads reset.
Manual Reactor Shutdown	1	Loss of stack monitor pump. Monitor blower found seized.

Figure IV.E.1
Monthly Surveillance and Maintenance (Sample Form)

OSTROP 13 Rev. 9 **SURVEILLANCE & MAINTENANCE FOR THE MONTH OF ______________**

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED *	DATE COMPLETED	REMARKS & INITIALS
1	REACTOR TANK HIGH AND LOW WATER LEVEL ALARMS	MAXIMUM MOVEMENT 3 INCHES	UP: ___ INCHES DOWN: ___ INCHES ANN: ___				
2	BULK WATER TEMPERATURE ALARM	FUNCTIONAL					
3	ERP INVENTORY AND INSPECTIONS	ERP App. B					
4	PRIMARY WATER Ph MEASUREMENT	MIN: 5 MAX: 8.5					
5	BULK SHIELD TANK WATER Ph MEASUREMENT	MIN: 5 MAX: 8.5					
6	CHANGE LAZY SUSAN FILTER	FILTER CHANGED					
7	REACTOR TOP CAM OIL LEVEL CHECK	OSTROP 13.10	NEED OIL?_____				
8	PROPANE TANK LIQUID LEVEL CHECK	> 50%					
9	PRIMARY PUMP BEARINGS OIL LEVEL	OSTROP 13.13	NEED OIL?_____				
10	WATER MONITOR CHECK						

* Date not to be exceeded is only applicable to shaded items. It is equal to the time completed last month plus six weeks.

Figure IV.E.2

Quarterly Surveillance and Maintenance (Sample Form)

OSTROP 14 Rev. 6 **SURVEILLANCE & MAINTENANCE FOR THE 1st / 2nd / 3rd / 4th QUARTER OF 20__**

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
1	REACTOR OPERATION COMMITTEE (ROC) AUDIT	QUARTERLY					
2	QUARTERLY ROC MEETING	QUARTERLY					
3	FUEL ELEMENT RADIATION LEVEL MEASUREMENTS IN WATER	< 23 R/hr @ 2' IN WATER					
4	ERP INSPECTIONS	QUARTERLY					
5	KEY INVENTORY	QUARTERLY					
6	ROTATING RACK CHECK FOR UNKNOWN SAMPLES	EMPTY					
7	WATER MONITOR ALARM CHECK	FUNCTIONAL					
8	STACK MONITOR CHECKS (OIL DRIVE MOTORS, H.V. READINGS)	MOTORS OILED					
		PART: 1150 V	____V				
		GAS: 900 V ±50	____V				
9	CHECK FILTER TAPE SPEED ON STACK MONITOR	1"/HR ± 0.2					
10	INCORPORATE 50.59 & ROCAS INTO DOCUMENTATION	QUARTERLY					
11	STACK MONITOR ALARM CIRCUIT CHECKS	ALARM ON					
12	ARM SYSTEM ALARM CHECKS	FUNCTIONAL					

CHAN	1	2	3	4	5	6	7	8	9	10	11	12	13	14
AUD														
LIGHT														
PANEL														
ANN														

* Date not to be exceeded is only applicable to shaded items. It is equal to the date completed last quarter plus four months.

Figure IV.E.2 (Continued)
Quarterly Surveillance and Maintenance (Sample Form)

OSTROP 14 Rev. 6 (CONTINUED) **SURVEILLANCE & MAINTENANCE FOR THE 1^{st} / 2^{nd} / 3^{rd} / 4^{th} QUARTER OF 20___**

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
13	OPERATOR LOG	a) ≥4 hours: at console (RO) or as Rx. Sup. (SRO) b) Complete Operating Exercise	a) TIME	b) OPERATING EXERCISE			

* Date not to be exceeded is only applicable to shaded items. It is equal to the date completed last quarter plus four months.

Figure IV.E.3
Semi-Annual Surveillance and Maintenance (Sample Form)

OSTROP 15 Rev. 10 **SEMI-ANNUAL SURVEILLANCE AND MAINTENANCE FOR 1st /2ed HALF 20___**

SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]									LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
1	FUNCTIONAL CHECKS OF REACTOR INTERLOCKS	NEUTRON SOURCE COUNT RATE INTERLOCK							NO WITHDRAW					
									cps					
		TRANSIENT ROD AIR INTERLOCK							NO PULSE					
		PULSE PROHIBIT ABOVE 1 kW							1 kW					
		TWO ROD WITHDRAWAL PROHIBIT							1 only					
		PULSE MODE ROD MOVEMENT INTERLOCK							NO MOVEMENT					
		MAXIMUM PULSE REACTIVITY INSERTION LIMIT							$2.50					
		PULSE INTERLOCK ON RANGE SWITCH							NO PULSE					
2	SAFETY	PERIOD SCRAM							3 sec					
3	CONTROL ROD WITHDRAWAL INSERTION & SCRAM TIMES		TRANS	SAFE	SHIM	REG			2 sec					
		SCRAM												
		WITHDRAWAL							50 sec					
		INSERTION							50 sec					
4	TEST PULSE	PULSE # ___ ___ MW ___							20% CHANGE	PULSE # ___ ___ MW ___				
5	REACTOR BAY VENTILATION SYSTEM SHUTDOWN TEST								DAMPERS CLOSE IN [illegible] SECONDS	[illegible] FLOOR ___ [illegible] FLOOR ___				
6	CALIBRATION OF THE FUEL ELEMENT TEMPERATURE CHANNEL								200 [illegible]					
7	EMERGENCY RESPONSE PLAN INVENTORY								ERP App. B					
8	CLEANING & LUBRICATION OF TRANSIENT ROD CARRIER INTERNAL BARREL													
9	LUBRICATION OF BALL NUT DRIVE ON TRANSIENT ROD CARRIER													

*Date not to be exceeded is only applicable to shaded items. It is equal to the date last time plus 7 ½ months.

Figure IV.E.3 (Continued)

Semi-Annual Surveillance and Maintenance (Sample Form)

OSTROP 15 Rev. 10 (CONTINUED) **SEMI-ANNUAL SURVEILLANCE AND MAINTENANCE FOR 1st /2nd HALF 20____**

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]		LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
10	LUBRICATION OF THE ROTATING RACK BEARINGS		10W OIL					
11	CONSOLE CHECK LIST		OSTROP 15.XI					
12	INVERTER MAINTENANCE		See User Manual					
13	STANDARD CONTROL ROD MOTOR CHECKS		LO-17 Bodine Oil					
14	ION CHAMBER RESISTANCE MEASUREMENTS WITH MEGGAR INDUCED VOLTAGE	SAFETY CHANNEL	NONE (Info Only)					
		%POWER CHANNEL	NONE (Info Only)					
15	FISSION CHAMBER RESISTANCE CALCULATION $R = \frac{800V}{\Delta I}$	@ 100 V, I = ________ AMPS @ 900 V, I = ________ AMPS ΔI = ________ AMPS R = ________ Ω	NONE (Info Only)					
16	FUNCTIONAL CHECK OF HOLDUP TANK WATER LEVEL ALARMS		OSTROP 15.XVIII	HIGH ______ FULL ______ GREEN LIGHT ______				
17	INSPECTION OF THE PNEUMATIC TRANSFER SYSTEM	BRUSH INSPECTION						
		SOLENOID VALVE INSPECTION	FUNCTIONAL					
		SAMPLE INSERTION TIME CHECK	≤6 SECONDS					

*Date not to be exceeded is only applicable to shaded items. It is equal to the date last time plus 7 ½ months.

Figure IV.E.4

Annual Surveillance and Maintenance (Sample Form)

OSTROP 16.0 Rev. 8 **Annual Surveillance and Maintenance for 20___**

	SURVEILLANCE AND MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]		LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
1	BIENNIAL INSPECTION OF CONTROL RODS	FFCRS	OSTROP 12.0					
		TRANS						
2	ANNUAL REPORT		NOV 1		OCT 1	NOV 1		
3	CONTROL ROD CALIBRATION	NORMAL	OSTROP 9.0					
		CLICIT						
		ICIT/DUMMY						
4	REACTOR POWER CALIBRATION		OSTROP 8.0					
5	CALIBRATION OF REACTOR TANK WATER TEMP		OSTROP 16.5					
6	CONTINUOUS AIR MONITOR CALIBRATION	Particulate Monitor	RCHPP 18					
		Gas Monitor						
7	STACK MONITOR CALIBRATION	Particulate Monitor	RCHPP 18 & 26					
		Gas Monitor						
8	AREA RADIATION MONITOR CALIBRATION		RCHPP 18.0					
9	DECOMMISSIONING COST UPDATE		N/A	N/A		AUGUST 1		
10	SNM PHYSICAL INVENTORY		N/A	N/A		OCTOBER 1		
11	MATERIAL BALANCE REPORTS		N/A	N/A		NOVEMBER		
12	STANDARD CONTROL ROD DRIVE INSPECTION		OSTROP 16.13					
13	HEU TO LEU CONVERSION REPORT		10 CFR 50.64		MAR 10	MAR 27		

** Date not to be exceeded is only applicable to shaded items. It is equal to the date completed last year plus 15 months. For biennial license requirements, it is equal to the date completed last time plus 2 ½ years.*

Figure IV.E.4 (Continued)

Annual Surveillance and Maintenance (Sample Form)

OSTROP 16.0 Rev. 8 (Continued) **Annual Surveillance and Maintenance for 20___**

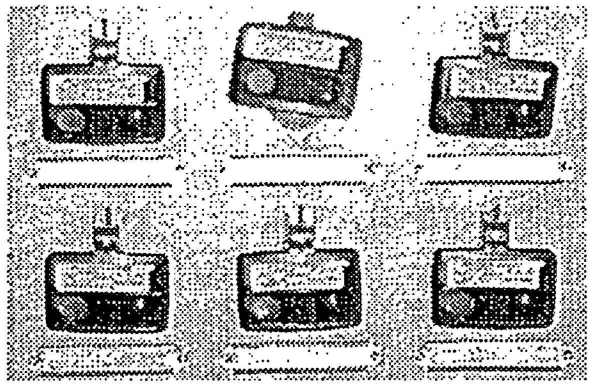
	SURVEILLANCE AND MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]		LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
14	EMERGENCY RESPONSE PLAN	GED TRAINING						
		GOOD SAM TRAINING						
		ERP REVIEW						
		ERP DRILL						
		FIRST AID FOR						
		FIRST AID FOR						
		EVACUATION DRILL						
		AUTO EVAC ANNOUNCEMENT TEST						
15	PHYSICAL SECURITY PLAN	OSP DES TRAINING						
		PSP REVIEW						
		PSP DRILL						
		LOCK/SAFE COMBO CHANGES						
		AUTHORIZATION LIST UPDATE						
16	REACTOR TANK AND CORE COMPONENT INSPECTION		NO POWDERY WHITE SPOTS					
17	EMERGENCY LIGHT LOAD TEST		RCHPP 18.0					
18	FUEL ELEMENT INSPECTION FOR SELECTED ELEMENTS (B1, B2, B3, B5, B6, C3, C5, D5, D6)		PASS GO/NO GO		Pulse #_____ Date_______			
19	FUNCTIONAL TEST OF THE REACTOR WATER LOW LEVEL ALARM		~3 INCHES	__________INS __________ANN				

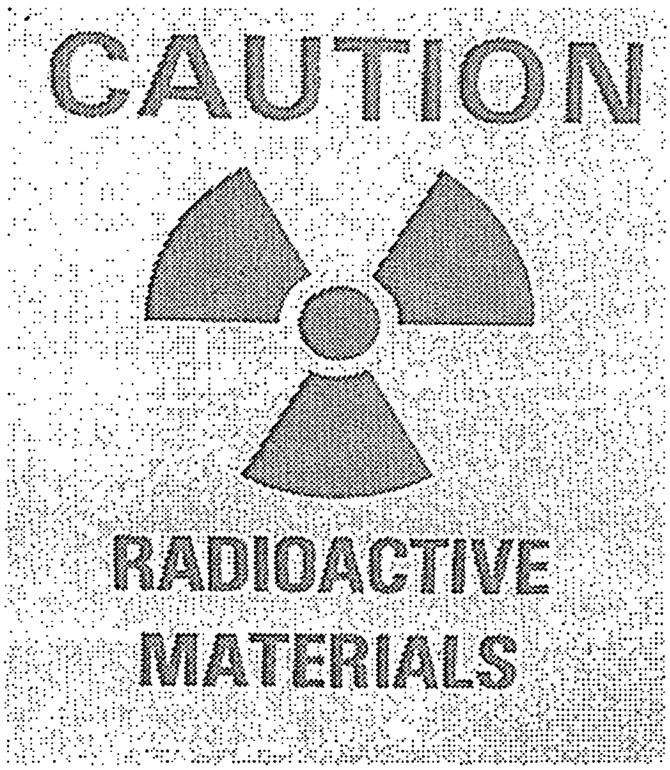
20	REACTOR OPERATOR LICENSE CONDITIONS	ANNUAL REQUALIFICATION				BIENNIAL MEDICAL		EVERY 6 YEARS LICENSE		
		WRITTEN EXAM		OPERATING TEST		DATE DUE	DATE COMPLETED	APPLICATION		EXPIRATION DATE
	OPERATOR NAME	DATE DUE	DATE PASSED	DATE DUE	DATE PASSED			DUE DATE	DATE MAILED	

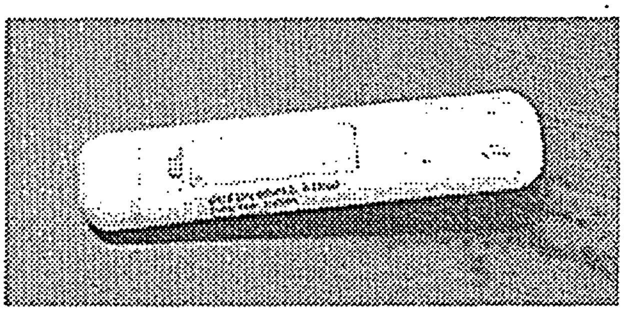
** Date not to be exceeded is only applicable to shaded items. It is equal to the date completed last year plus 15 months. For biennial license requirements, it is equal to the date completed last time plus 2 ½ years.*

Part V

Protection







Part V
PROTECTION

A. Introduction

This section of the report deals with the radiation protection program at the OSU Radiation Center. The purpose of this program is to ensure the safe use of radiation and radioactive material in the Center's teaching, research, and service activities, and in a similar manner to ensure the fulfillment of all regulatory requirements of the state of Oregon, the U.S. Nuclear Regulatory Commission, and other regulatory agencies. The comprehensive nature of the program is shown in Table V.A.1, which lists the program's major radiation protection requirements and the performance frequency for each item.

The radiation protection program is implemented by a staff consisting of a Senior Health Physicist, a Health Physicist, and several part-time Health Physics Monitors (see Part II.F). Assistance is also provided by the reactor operations group, the neutron activation analysis group, the Scientific Instrument Technician, and the Radiation Center Director.

The data contained in the following sections have been prepared to comply with the current requirements of Nuclear Regulatory Commission (NRC) Facility License No. R-106 (Docket No. 50-243) and the Technical Specifications contained in that license. The material has also been prepared in compliance with Oregon Office of Energy Rule No. 345-30-010, which requires an annual report of environmental effects due to research reactor operations.

Within the scope of Oregon State University's radiation protection program, it is standard operating policy to maintain all releases of radioactivity to the unrestricted environment and all exposures to radiation and radioactive materials at levels which are consistently "as low as reasonably achievable" (ALARA).

B. Environmental Releases

The annual reporting requirements in the OSTR Technical Specifications state that the licensee (OSU) shall include "a summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the licensee, as measured at, or prior to, the point of such release or discharge." The liquid and gaseous effluents released, and the solid waste generated and transferred are discussed briefly below. Data regarding these effluents are also summarized in detail in the designated tables.

1. Liquid Effluents Released

a. Liquid Effluents Released

Oregon State University has implemented a policy to reduce the volume of radioactive liquid effluents to an absolute minimum. For example, water used during the ion exchanger resin change is now recycled as reactor makeup water. Waste water from Radiation Center laboratories and the OSTR is collected at a holdup tank prior to release to the sanitary sewer. Whenever possible, liquid effluent is analyzed for radioactivity content at the time it is released to the collection point. However, liquids are always analyzed for radioactivity before the holdup tank is discharged into the unrestricted area (the sanitary sewer system). For this reporting period, the Radiation Center and reactor made one liquid effluent release to the sanitary sewer. All Radiation Center and reactor facility liquid effluent data pertaining to this release are contained in Table V.B.1.a.

b. Liquid Waste Generated and Transferred

Liquid waste generated from glassware and laboratory experiments is transferred by the campus Radiation Safety Office to its waste processing facility. The annual summary of liquid waste generated and transferred is contained in Table V.B.1.b.

2. Airborne Effluents Released

Airborne effluents are discussed in terms of the gaseous component and the particulate component.

a. Gaseous Effluents

Gaseous effluents from the reactor facility are monitored by the reactor stack effluent monitor. Monitoring is continuous, i.e., prior to, during, and after reactor operations. It is normal for the reactor facility stack effluent monitor to begin operation as one of the first systems in the morning and to cease operation as one of the last systems at the end of the day. All gaseous effluent data for this reporting period are summarized in Table V.B.2.

b. Particulate Effluents

Particulate effluents from the reactor facility are also monitored by the reactor facility stack effluent monitor.

Evaluation of the detectable particulate radioactivity in the stack effluent confirmed its origin as naturally-occurring radon daughter products, within a range of approximately 3×10^{-11} μCi/ml to 1×10^{-9} μCi/ml. This particulate radioactivity is predominantly ^{214}Pb and ^{214}Bi, which is not associated with reactor operations.

There was no release of particulate effluents with a half life greater than eight days and therefore the reporting of the average concentration of radioactive particulates with half lives greater than eight days is not applicable.

3. Solid Waste Released

Data for the radioactive material in the solid waste generated and transferred during this reporting period are summarized in Table V.B.3 for both the reactor facility and the Radiation Center. Solid radioactive waste is routinely transferred to the OSU Radiation Safety Office. Until this waste is disposed of by the Radiation Safety Office, it is held along with other campus radioactive waste on the University's state of Oregon radioactive materials license.

Solid radioactive waste is disposed of by the University Radiation Safety Office by transfer to the University's radioactive waste disposal vendor, Thomas Gray Associates, Inc., for burial at its installation located near Richland, Washington.

C. Personnel Doses

The OSTR annual reporting requirements specify that the licensee shall present a summary of the radiation exposure received by facility personnel and visitors. For the purposes of this report, the summary includes all Radiation Center personnel who may have received exposure to radiation. These personnel have been categorized into six groups: facility operating personnel, key facility research personnel, facilities services maintenance personnel, students in laboratory classes, police and security personnel, and visitors.

Facility operating personnel include the reactor operations and health physics staff. The dosimeters used to monitor these individuals include quarterly TLD badges, quarterly track-etch/albedo neutron dosimeters, monthly TLD (finger) extremity dosimeters, and pocket ion chambers.

Key facility research personnel consist of Radiation Center staff, faculty, and graduate students who perform research using the reactor, reactor-activated materials, or using other research facilities present at the Center. The individual dosimetry requirements for these personnel will vary with the type of research being conducted, but will generally include a quarterly TLD film badge and TLD (finger) extremity dosimeters. If the possibility of neutron exposure exists, researchers are also monitored with a track-etch/albedo neutron dosimeter.

Facilities Services maintenance personnel are normally issued a gamma sensitive electronic dosimeter as their basic monitoring device. A few Facilities Services personnel who routinely perform maintenance on mechanical or refrigeration equipment are issued a quarterly $X\beta(\gamma)$ TLD badge and other dosimeters as appropriate for the work being performed.

Students attending laboratory classes are issued quarterly $X\beta(G)$ TLD badges, TLD (finger) extremity dosimeters, and track-etch/albedo or other neutron dosimeters, as appropriate.

Students or small groups of students who attend a one-time laboratory demonstration and do not handle radioactive materials are usually issued a gamma sensitive electronic dosimeter. These results are not included with the laboratory class students.

OSU police and security personnel are issued a quarterly $X\beta(\gamma)$ TLD badge to be used during their patrols of the Radiation Center and reactor facility.

Visitors, depending on the locations visited, may be issued a gamma sensitive electronic dosimeters. OSU Radiation Center policy does not normally allow people in the visitor category to become actively involved in the use or handling of radioactive materials.

An annual summary of the radiation doses received by each of the above six groups is shown in Table V.C.1. There were no personnel radiation exposures in excess of the limits in 10 CFR 20 or state of Oregon regulations during the reporting period.

D. Facility Survey Data

The OSTR Technical Specifications require an annual summary of the radiation levels and levels of contamination observed during routine surveys performed at the facility. The Center's comprehensive area radiation monitoring program encompasses the Radiation Center as well as the OSTR, and therefore monitoring results for both facilities are reported.

1. Area Radiation Dosimeters

Area monitoring dosimeters capable of integrating the radiation dose are located at strategic positions throughout the reactor facility and Radiation Center. All of these dosimeters contain at least a standard personnel-type beta-gamma film or TLD pack. In addition, for key locations in the reactor facility and for certain Radiation Center laboratories a CR-39 plastic track-etch neutron detector has also been included in the monitoring package.

The total dose equivalent recorded on the various reactor facility dosimeters is listed in Table V.D.1 and the total dose equivalent recorded on the Radiation Center area dosimeters is listed in Table V.D.2. Generally, the characters following the MRC (Monitor Radiation Center) designator show the room number or location.

2. Routine Radiation and Contamination Surveys

The Center's program for routine radiation and contamination surveys consists of daily, weekly, and monthly measurements throughout the TRIGA reactor facility and Radiation Center. The frequency of these surveys is based on the nature of the radiation work being carried out at a particular location or on other factors which indicate that surveillance over a specific area at a defined frequency is desirable.

The primary purpose of the routine radiation and contamination survey program is to assure regularly scheduled surveillance over selected work areas in the reactor facility and in the Radiation Center, in order to provide current and characteristic data on the status of radiological conditions. A second objective of the program is to assure frequent on-the-spot personal observations (along with recorded data), which will provide advance warning of needed corrections and thereby help to ensure the safe use and handling of radiation sources and radioactive materials. A third objective, which is really derived from successful execution of the first two objectives, is to gather and document information which will help to ensure that all phases of the operational and radiation protection programs are meeting the goal of keeping radiation doses to personnel and releases of radioactivity to the environment "as low as reasonably achievable" (ALARA).

The annual summary of radiation and contamination levels measured during routine facility surveys for the applicable reporting period is given in Table V.D.3.

E. Environmental Survey Data

The annual reporting requirements of the OSTR Technical Specifications include "an annual summary of environmental surveys performed outside the facility."

1. Gamma Radiation Monitoring

a. On-site Monitoring

Monitors used in the on-site gamma environmental radiation monitoring program at the Radiation Center consist of the reactor facility stack effluent monitor described in Section V.B.2 and nine environmental monitoring stations. These stations consist of a polyethylene bottle placed inside a PVC tube attached to the reactor building perimeter fence at a height of four feet.

Each fence environmental station is equipped with an OSU supplied and processed TLD area monitor (normally three Harshaw ^{7}LiF TLD-700 chips per ^{7}Li monitor in a plastic "LEGO" mount). These monitors are exchanged and processed quarterly. The total number of TLD samples for the reporting period was 108 (9 stations x 3 chips per station per quarter x 4 quarters per year). A summary of this TLD data is shown in Table V.E.1.

During this reporting period, each fence environmental station utilized an LIF TLD monitoring packet supplied and processed by ICN Worldwide Dosimetry Service (ICN), Costa Mesa, California. Each ICN packet contained three LIF TLDs and was exchanged quarterly for a total of 108 samples during the reporting period (9 stations x 3 TLDs per station x 4 quarters). The total number of ICN TLD samples for the reporting period was 90. A summary of the ICN TLD data is also shown in Table V.E.1.

Monthly measurements of the direct gamma dose rate (μrem h^{-1}) were also made at each fence monitoring station. These measurements were made with a Bicron micro-rem per hour survey meter containing a 1" x 1" NaI detector.

A total of 108 μrem h^{-1} measurements were taken (9 stations per month x 12 months per year). The total calculated dose equivalent was determined by averaging the 12 separate μrem h^{-1} measurements and multiplying this average by 8760 hours per year. A summary of this data is shown in Table V.E.1.

From Table V.E.1 it is concluded that the doses recorded by the dosimeters on the TRIGA facility fence can be attributed to natural background radiation, which is about 110 mrem per year for Oregon (Refs. 1, 2).

b. Off-site Monitoring

The off-site gamma environmental radiation monitoring program consists of twenty monitoring stations surrounding the Radiation Center (see Figure V.E.2) and six stations located within a 5 mile radius of the Radiation Center.

Each off-site radiation monitoring station is equipped with an OSU-supplied and processed TLD monitor. Each monitor consists of three Harshaw ^{7}LiF TLD-700 chips in a plastic "LEGO" mount. The mount is placed in a polyethylene bottle inside a PVC tube which is attached to the station's post about four feet above the ground (MRCTE 21 and MRCTE 22 are mounted on the roof of the EPA Laboratory and National Forage Seed Laboratory, respectively). These monitors are exchanged and processed quarterly, and the total number of TLD samples during the current one-year reporting period was 240 (20 stations x 3 chips per station per quarter x 4 quarters per year). A summary of the OSU off-site TLD data is provided in Table V.E.2. The total number of ICN TLD samples for the reporting period was 144 (12 station x 3 TLDs per station x 4 quarters). The total number of ICN TLD samples for the reporting period was 128. A summary of ICN TLD data for the off-site monitoring stations is also given in Table V.E.2.

In a manner similar to that described for the on-site fence stations, monthly measurements of the direct gamma exposure rate in microrem per hour (μrem h^{-1}) are made at each of the twenty off-site radiation monitoring stations. As noted before, these measurements are made with a Bicron micro-rem per hour survey meter containing a 1" x 1" NaI detector. A total of 240 μrem h^{-1} measurements were made during the reporting period (21 stations per month x 12 months per year). The total dose equivalent for each station was determined by averaging the 12 separate μrem h^{-1} measurements and multiplying this average by 8760 hours per year. A summary of these data is given in Table V.E.2.

After a review of the data in Table V.E.2, it is concluded that, like the dosimeters on the TRIGA facility fence, all of the doses recorded by the off-site dosimeters can be attributed to natural background radiation, which is about 110 mrem per year for Oregon (Refs. 1, 2).

2. Soil, Water, and Vegetation Surveys

The soil, water, and vegetation monitoring program consists of the collection and analysis of a limited number of samples in each category on a quarterly basis. The program monitors highly unlikely radioactive material releases from either the TRIGA reactor facility or the OSU Radiation Center, and also helps indicate the general trend of the radioactivity concentration in each of the various substances sampled. See Figure V.E.1 for the locations of the sampling stations for grass (G), soil (S), water (W) and rainwater (RW) samples. Most locations are within a 1000 foot radius of the reactor facility and the Radiation Center. In general, samples are collected over a local area having a radius of about ten feet at the positions indicated in Figure V.E.1.

There are a total of 22 quarterly sampling locations: four soil locations, four water locations (when water is available), and fourteen vegetation locations. The total number of samples taken during this reporting period is 86 (16 soil samples, 14 water samples, and 56 vegetation samples).

The annual average concentration of total net beta radioactivity (minus tritium) for samples collected at each environmental soil, water, and vegetation sampling location (sampling station) is listed in Table V.E.3. Calculation of the total net beta disintegration rate incorporates subtraction of only the counting system background from the gross beta counting rate, followed by application of an appropriate counting system efficiency.

The annual average concentrations were calculated using sample results which exceeded the lower limit of detection (LLD), except that sample results which were less than or equal to the LLD were averaged in at the corresponding LLD concentration. Table V.E.4 gives the average LLD concentration and the range of LLD values for each sample category for the current reporting period.

As used in this report, the LLD has been defined as the amount or concentration of radioactive material (in terms of μCi per unit volume or unit mass) in a representative sample, which has a 95% probability of being detected.

Identification of specific radionuclides is not routinely carried out as part of this monitoring program, but would be conducted if unusual radioactivity levels above natural background were detected. However, from Table V.E.3 it can be seen that the levels of radioactivity detected were consistent with naturally occurring radioactivity and comparable to values reported in previous years.

F. Radioactive Material Shipments

A summary of the radioactive material shipments originating from the TRIGA reactor facility, NRC license R-106, is shown in Table V.F.1. A similar summary for shipments originating from the Radiation Center's state of Oregon radioactive materials license ORE 90005 is shown in Table V.F.2. A summary of radioactive material shipments exported under Nuclear Regulatory Commission general license 10 CFR 110.23 is shown in Table V.F.3.

G. References

1. U. S. Environmental Protection Agency, "Estimates of Ionizing Radiation Doses in the United States, 1960-2000," ORP/CSD 72-1, Office of Radiation Programs, Rockville, Maryland (1972).

2. U. S. Environmental Protection Agency, "Radiological Quality of the Environment in the United States, 1977," EPA 520/1-77-009, Office of Radiation Programs; Washington, D.C. 20460 (1977).

Table V.A.1

Radiation Protection Program Requirements and Frequencies

FREQUENCY	RADIATION PROTECTION REQUIREMENT
Daily/Weekly/Monthly	Perform routine area radiation/contamination monitoring.
Monthly	Perform routine response checks of radiation monitoring instruments. Monitor radiation levels (μrem h^{-1}) at the environmental monitoring stations. Collect and analyze TRIGA primary, secondary, and make-up water. Exchange personnel dosimeters and inside area monitoring dosimeters, and review exposure reports. Inspect laboratories. Check emergency safety equipment. Perform neutron generator contamination survey. Calculate previous month's gaseous effluent discharge.
As Required	Process and record solid waste and liquid effluent discharges. Prepare and record radioactive material shipments. Survey and record incoming radioactive materials receipts. Perform and record special radiation surveys. Perform thyroid and urinalysis bioassays. Conduct orientations and training. Issue radiation work permits and provide health physics coverage for maintenance operations.
Quarterly	Prepare, exchange and process environmental TLD packs. Collect and process environmental soil, water, and vegetation samples. Conduct orientations for classes using radioactive materials. Collect and analyze sample from reactor stack effluent line. Exchange personnel dosimeters and inside area monitoring dosimeters, and review exposure reports.
Semi-Annual	Leak test and inventory sealed sources. Conduct floor survey of corridors and reactor bay. Inventory and inspect Radiation Center equipment located at Good Samaritan Hospital.
Annual	Calibrate portable radiation monitoring instruments and personnel pocket ion chambers. Calibrate reactor stack effluent monitor, continuous air monitors, remote area radiation monitors, water monitor, and air samplers. Measure face air velocity in laboratory hoods and exchange dust-stop filters and HEPA filters as necessary. Inventory and inspect Radiation Center emergency equipment. Conduct facility radiation survey of the ^{60}Co irradiators. Conduct personnel dosimeter training. Perform contamination smear survey of Radiation Center ventilation stacks. Update decommissioning logbook.

Table V.B.1.a
Monthly Summary of Liquid Effluent Releases to the Sanitary Sewer[1,2]
(OSTR Contribution Shown in ( ) and Bold Print)

Date of Discharge (Month and Year)	Total Quantity of Radioactivity Released (Curies)	Detectable Radio-nuclides in the Waste	Specific Activity For Each Detectable Radionuclide in the Waste, Where the Release Concentration Was >1 x 10^{-7} µCi/cm^3 (µCi ml^{-1})	Total Quantity of Each Detectable Radionuclide Released in the Waste (Curies)	Average Concentration of Released Radioactive Material at the Point of Release (µCi ml^{-1})	Percent of Applicable Monthly Average Concentration for Released Radioactive Material (%) [3]	Total Volume of Liquid Effluent Released Including Diluent [4] (gal)
January 2004	1.26 x 10^{-4}	^3H	1.79 x 10^{-5}	1.26 x 10^{-4}	1.79 x 10^{-5}	0.1	1857
Annual Total for Radiation Center	1.26 x 10^{-4}	^3H	1.79 x 10^{-5}	1.26 x 10^{-4}	1.79 x 10^{-5}	0.1	1857
OSTR Contribution to Above	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(1) OSU has implemented a policy to reduce to the absolute minimum radioactive wastes disposed to the sanitary sewer. There were no liquid effluent releases during months not listed.
(2) The OSU operational policy is to subtract only detector background from the water analysis data and not background radioactivity in the Corvallis city water.
(3) Based on values listed in 10 CFR 20, Appendix B to 20.1001 - 20.2401, Table 3, which are applicable to sewer disposal.
(4) The total volume of liquid effluent plus diluent does not take into consideration the additional mixing with the over 250,000 gallons per year of liquids and sewage normally discharged by the Radiation Center complex into the same sanitary sewer system.
(5) Less than the lower limit of detection at the 95% confidence level.

Table V.B.1.b

Annual Summary of Liquid Waste Generated and Transferred

Origin of Liquid Waste	Volume of Liquid Waste Packaged(1) (gallons)	Detectable Radionuclides in the Waste	Total Quantity of Radioactivity in the Waste (Curies)	Dates of Waste Pickup for Transfer to the Waste Processing Facility
TRIGA Reactor Facility	None	---	---	---
Radiation Center Laboratories	16.3	^{238}U, ^{3}H, ^{14}C, ^{90}Sr	5.56×10^{-3}	9/16/03[1] 6/22/04
TOTAL	16.3	^{238}U, ^{3}H, ^{14}C, ^{90}Sr	5.56×10^{-3}	---

(1) TRIGA and Radiation Center liquid waste is picked up by the Radiation Safety Office for transfer to its waste processing facility for final packaging.

(2) The short-lived waste was held by the Radiation Safety Office for decay.

Table V.B.2

Monthly TRIGA Reactor Gaseous Waste Discharges and Analysis[1]

Month	Total Estimated Activity Released (Curies)	Total Estimated Quantity of Argon-41 Released[2] (Curies)	Estimated Atmospheric Diluted Concentration of Argon-41 at Point of Released (μCi/cc)	Fraction of the Technical Specification Annual Average Argon-41 Concentration Limit (%)
July	0.17	0.17	1.45E-08	0.36
August	0.12	0.12	1.04E-08	0.26
September	0.15	0.15	1.28E-08	0.32
October	0.17	0.17	1.44E-08	0.36
November	0.21	0.21	1.79E-08	0.45
December	0.13	0.13	1.07E-08	0.27
January	0.16	0.16	1.37E-08	0.34
February	0.20	0.20	1.83E-08	0.46
March	0.22	0.22	1.88E-08	0.47
April	0.00	0.00	0.00E+00	0.00
May	0.02	0.02	1.45E-09	0.04
June	0.14	0.14	1.21E-08	0.30
TOTAL ('03-'04)	1.68	1.68	1.21E-08	0.30

(1) Airborne effluents from the OSTR contained no detectable particulate radioactivity resulting from reactor operations, and there were no releases of *any* radioisotopes in airborne effluents in concentrations greater than 20% of the applicable effluent concentration. (20% is a value taken from the OSTR Technical Specifications.)

(2) Routine gamma spectroscopy analysis of the gaseous radioactivity in the OSTR stack discharge indicated the only detectable radionuclide was argon-41.

Table V.B.3

Annual Summary of Solid Waste Generated and Transferred

Origin of Solid Waste	Volume of Solid Waste Packaged[1] (Cubic Feet)	Detectable Radionuclides in the Waste	Total Quantity of Radioactivity in Solid Waste (Curies)	Dates of Waste Pickup for Transfer to the OSU Waste Processing Facility
TRIGA Reactor Facility	26.25	^{137}Cs, ^{60}Co, ^{58}Co, ^{75}Se, ^{152}Eu, ^{154}Eu, ^{3}H, ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{124}Sb, ^{89}Rb	5.9×10^{-4}	9/18/03, 4/7/04, 6/22/04
Radiation Center Laboratories	24.25	^{32}P, ^{238}U, ^{3}H, ^{90}Sr, ^{60}Co, ^{152}Eu, ^{68}Ge, ^{86}Rb, ^{14}C, ^{137}Cs, ^{75}Se	6.9×10^{-1}	9/18/03, 4/7/04, 5/12/04, 6/22/04
TOTAL	50.50	See Above	6.9×10^{-1}	---

(1) TRIGA and Radiation Center laboratory waste is picked up by the Radiation Safety Office for transfer to its waste processing facility for final packaging.

Table V.C.1

Annual Summary of Personnel Radiation Doses Received

Personnel Group	Average Annual Dose(1)		Greatest Individual Dose(1)		Total Person-mrem For the Group(1)	
	Whole Body (mrem)	Extremities (mrem)	Whole Body (mrem)	Extremities (mrem)	Whole Body (mrem)	Extremities (mrem)
Facility Operating Personnel	16	60	106	517	379	1440
Key Facility Research Personnel	0	<1	0	23	0	23
Facilities Services Maintenance Personnel	0	N/A	0	N/A	0	N/A
Laboratory Class Students	<1	<1	13	22	44	22
Campus Police and Security Personnel	<1	N/A	24	N/A	35	N/A
Visitors	<1	N/A	46	N/A	102	N/A

(1) "N/A" indicates that there was no extremity monitoring conducted or required for the group.

Table V.D.1

Total Dose Equivalent Recorded on Area Dosimeters Located Within the TRIGA Reactor Facility

Monitor I.D.	TRIGA Reactor Facility Location (See Figure V.D.1)	Total Recorded Dose Equivalent[(1)(2)]	
		$x\beta(\gamma)$ (mrem)	Neutron (mrem)
MRCTNE	D104: North Badge East Wall	179	ND
MRCTSE	D104: South Badge East Wall	155	ND
MRCTSW	D104: South Badge West Wall	370	ND
MRCTNW	D104: North Badge West Wall	140	ND
MRCTWN	D104: West Badge North Wall	205	ND
MRCTEN	D104: East Badge North Wall	420	ND
MRCTES	D104: East Badge South Wall	838	ND
MRCTWS	D104: West Badge South Wall	347	ND
MRCTTOP	D104: Reactor Top Badge	400	ND
MRCTHXS	D104A: South Badge HX Room	421	ND
MRCTHXW	D104A: West Badge HX Room	178	ND
MRCD-302	D302: Reactor Control Room	254	ND
MRCD-302A	D302A: Reactor Supervisor's Office	69	N/A
MRCBP1	D104: Beam Port Number 1	138	ND
MRCBP2	D104: Beam Port Number 2	173	ND
MRCBP3	D104: Beam Port Number 3	824	ND
MRCBP4	D104: Beam Port Number 4	424	ND

(1) The total recorded dose equivalent values do not include natural background contribution and, reflect the summation of the results of four quarterly beta-gamma dosimeters or four quarterly fast neutron dosimeters for each location. A total dose equivalent of "ND" indicates that each of the dosimeters during the reporting period was less than the vendor's gamma dose reporting threshold of 10 mrem or that each of the fast neutron dosimeters was less than the vendor's threshold of 10 mrem. "N/A" indicates that there was no neutron monitor at that location.

(2) These dose equivalent values do not represent radiation exposure through an exterior wall directly into an unrestricted area.

Table V.D.2

Total Dose Equivalent Recorded on Area Dosimeters
Located Within the Radiation Center

Monitor I.D.	Radiation Center Facility Location (See Figure V.D.1)		Total Recorded Dose Equivalent[1]	
			$x\beta(\gamma)$ (mrem)	Neutron (mrem)
MRCA100	A100:	Receptionist's Office	10	N/A
MRCBRF	A102H:	Front Personnel Dosimetry Storage Rack	48	N/A
MRCA120	A120:	Stock Room	60	N/A
MRCA120A	A120A:	NAA Temporary Storage	10	N/A
MRCA126	A126:	Radioisotope Research Lab	78	N/A
MRCCO-60	A128:	^{60}Co Irradiator Room	232	N/A
MRCA130	A130:	Shielded Exposure Room	55	N/A
MRCA132	A132:	TLD Equipment Room	48	N/A
MRCA138	A138:	Health Physics Laboratory	44	N/A
MRCA146	A146:	Gamma Analyzer Room (Storage Cave)	16	N/A
MRCB100	B100:	Gamma Analyzer Room (Storage Cave)	63	N/A
MRCB114	B114:	α Lab (^{226}Ra Storage Facility)	1,566	ND
MRCB119-1	B119:	Source Storage Room	247	N/A
MRCB119-2	B119:	Source Storage Room	419	N/A
MRCB119A	B119A:	Sealed Source Storage Room	5,053	2,717
MRCB120	B120:	Instrument Calibration Facility	62	N/A
MRCB122-2	B122:	Radioisotope Storage Hood	40	N/A
MRCB122-3	B122:	Radioisotope Research Laboratory	66	N/A
MRCB124-1	B124:	Radioisotope Research Lab (Hood)	33	N/A
MRCB124-2	B124:	Radioisotope Research Laboratory	38	N/A
MRCB124-6	B124:	Radioisotope Research Laboratory	53	N/A
MRCB128	B128:	Instrument Repair Shop	32	N/A
MRCC100	C100:	Radiation Center Director's Office	11	N/A
MRCC106A	C106A:	Staff Lunch Room	61	N/A
MRCC106B	C106:	Solvent Storage Room	50	N/A
MRCC106-H	C106H:	East Loading Dock	54	N/A
MRCC118	C118:	Radiochemistry Laboratory	0	N/A
MRCC120	C120:	Student Counting Laboratory	0	N/A
MRCF100	F100:	APEX Facility	0	N/A

See footnotes following the table.

Table V.D.2 (continued)

Total Dose Equivalent Recorded on Area Dosimeters
Located Within the Radiation Center

Monitor I.D.	Radiation Center Facility Location (See Figure V.D.1)		Total Recorded Dose Equivalent[1]	
			xβ(γ) (mrem)	Neutron (mrem)
MRCF102	F102:	APEX Control Room	23	N/A
MRCB125N	B125:	Gamma Analyzer Room (Storage Cave)	188	N/A
MRCB125S	B125:	Gamma Analyzer Room	10	N/A
MRCC124	C124:	Student Computer Laboratory	43	N/A
MRCC130-1	C130:	Radioisotope Laboratory (Hood)	37	N/A
MRCD100	D100:	Reactor Support Laboratory	113	N/A
MRCD102	D102:	Pneumatic Transfer Terminal Lab	250	ND
MRCD102-H	D102H:	1st Floor Corridor at D102	92	ND
MRCD106-H	D106H:	1st Floor Corridor at D106	143	N/A
MRCD200	D200:	Reactor Administrators's Office	226	ND
MRCD202	D202:	Senior Health Physicist's Office	220	ND
MRCBRR	D200H:	Rear Personnel Dosimetry Storage Rack	57	N/A
MRCD204	D204	Health Physicist Office	164	ND
MRCF104	F104:	ATHRL	46	ND
MRCD300	D300:	3rd Floor Conference Room	163	ND

(1) The total recorded dose equivalent values do not include natural background contribution and, except as noted, reflect the summation of the results of 4 quarterly beta-gamma dosimeters or four quarterly fast neutron dosimeters for each location. A total dose equivalent of "ND" indicates that each of the dosimeters during the reporting period was less than the vendor's gamma dose reporting threshold of 10 mrem or that each of the fast neutron dosimeters was less than the vendor's threshold of 10 mrem. "N/A" indicates that there was no neutron monitor at that location.

Table V.D.3

Annual Summary of Radiation Levels and Contamination Levels Observed Within the Reactor Facility and Radiation Center During Routine Radiation Surveys

Accessible Location (See Figure V.D.1)	Whole Body Radiation Levels (mrem/hr)		Contamination Levels[1] (dpm/cm²)	
	Average	Maximum	Average	Maximum
TRIGA Reactor Facility:				
Reactor Top (D104)	<1	90	<500	<500
Reactor 2nd Deck Area (D104)	2.40	27	<500	<500
Reactor Bay SW (D104)	<1	2.5	<500	<500
Reactor Bay NW (D104)	<1	67	<500	<500
Reactor Bay NE (D104)	<1	6	<500	12,321
Reactor Bay SE (D104)	<1	8	<500	1,739
Class Experiments (D104, D302)	N/A	N/A	<500	<500
Demineralizer Tank--Outside Shielding (D104A)	<1	18	<500	<500
Particulate Filter--Outside Shielding (D104A)	<1	2.2	<500	<500
Radiation Center:				
NAA Counting Rooms (A146, B100)	<1	1.75	<500	<500
Health Physics Laboratory (A138)	<1	<1	<500	<500
^{60}Co Irradiator Room and calibration rooms (A128, A130, B120)	<1	3.90	<500	<500
Radiation Research Labs (B108, B114, B122, B124, C130, C132A)	<1	8	<500	<500
Radioactive Source Storage (A120A, B119, B119A)	1.64	5.50	<500	<500
Student Chemistry Laboratory (C118)	<1	<1	<500	<500
Student Counting Laboratory (C120)	<1	<1	<500	<500
Operations Counting Room (B136, C123)	<1	<1	<500	<500
Pneumatic Transfer Laboratory (D102)	<1	4.50	<500	<500
TRIGA Tube Wash Room (D100)	<1	1.80	<500	<500

(1) <500 dpm/100 cm² = Less than the lower limit of detection for the portable survey instrument used.

Table V.E.1

Total Dose Equivalent at the TRIGA Reactor Facility Fence

Fence Environmental Monitoring Station (See Figure V.E.1)	Total Recorded Dose Equivalent (Including Background) Based on ICN TLDs(1) (mrem)	Total Recorded Dose Equivalent (Including Background) Based on OSU TLDs(2)(3) (mrem)	Total Calculated Dose Equivalent (Including Background) Based on the Annual Average $\mu rem\ h^{-1}$ Dose Rate(3) (mrem)
MRCFE-1	91 ± 3	75 ± 7	77 ± 20
MRCFE-2	86 ± 3	70 ± 4	65 ± 15
MRCFE-3	80 ± 3	70 ± 7	66 ± 18
MRCFE-4	83 ± 2	73 ± 6	72 ± 9
MRCFE-5	88 ± 6	63 ± 4	67 ± 17
MRCFE-6	86 ± 2	70 ± 5	77 ± 17
MRCFE-7	81 ± 3	66 ± 14	66 ± 12
MRCFE-8	81 ± 3	67 ± 5	65 ± 17
MRCFE-9	91 ± 6	61 ± 9	57 ± 15

(1) Average Corvallis area natural background using ICN TLDs totals 72 ± 4 mrem for the same period.

(2) OSU fence totals include a measured natural background contribution of 64 ± 5 mrem.

(3) ± values represent the standard deviation of the total value at the 95% confidence level.

Table V.E.2

Total Dose Equivalent at the Off-Site Gamma Radiation Monitoring Stations

Off-Site Radiation Monitoring Station[1] (See Figure V.E.2)	Total Recorded Dose Equivalent (Including Background) Based on ICN TLDs[2] (mrem)	Total Recorded Dose Equivalent (Including Background) Based on OSU TLDs[3][4] (mrem)	Total Calculated Dose Equivalent (Including Background) Based on the Annual Average µrem/h Exposure Rate[4] (mrem)
MRCTE-2L	---	62 ± 4	49 ± 12
MRCTE-3	88 ± 2	68 ± 9	74 ± 17
MRCTE-4	85 ± 1	87 ± 35	56 ± 12
MRCTE-5L	---	64 ± 8	61 ± 15
MRCTE-6	75 ± 1	57 ± 7	50 ± 11
MRCTE-7L	---	55 ± 5	64 ± 13
MRCTE-8	91 ± 1	72 ± 13	74 ± 13
MRCTE-9	90 ± 3	57 ± 12	64 ± 12
MRCTE-10	83 ± 3	75 ± 16	51 ± 11
MRCTE-12	91 ± 3	69 ± 9	62 ± 13
MRCTE-13L	---	65 ± 9	62 ± 16
MRCTE-14L	---	60 ± 9	50 ± 13
MRCTE-15	75 ± 2	62 ± 8	50 ± 8
MRCTE-16L	---	79 ± 30	64 ± 4
MRCTE-17	60 ± 1	56 ± 8	52 ± 12
MRCTE-18L	---	69 ± 7	54 ± 9
MRCTE-19	97 ± 7	68 ± 4	68 ± 12
MRCTE-20L	---	68 ± 8	62 ± 16
MRCTE-21	70 ± 2	73 ± 12	52 ± 12
MRCTE-22	74 ± 3	57 ± 7	46 ± 12

(1) Monitoring stations coded with an "L" contained one standard OSU TLD pack only. Stations not coded with an "L" contained, in addition to the OSU TLD pack, one ICN TLD monitoring pack.

(2) Average Corvallis area natural background using ICN TLDs totals 72 ± 4 mrem for the same period.

(3) OSU off-site totals include a measured natural background contribution of 64 ± 5 mrem.

(4) ± values represent the standard deviation of the total value at the 95% confidence level.

Table V.E.3

Annual Average Concentration of the Total Net Beta Radioactivity (Minus ^3H) for Environmental Soil, Water, and Vegetation Samples

Sample Location (See Figure V.E.2)	Sample Type	Annual Average Concentration of the Total Net Beta (Minus ^3H) Radioactivity[1]	Reporting Units
1-W	Water	5.88E-08 ± 1.99E-09[2]	µCi ml^{-1}
4-W	Water	5.87E-08 ± 1.67E-09[2]	µCi ml^{-1}
11-W	Water	5.85E-08 ± 7.57E-10[2]	µCi ml^{-1}
19-RW	Water	9.48E-08 ± 1.43E-07[2]	µCi ml^{-1}
3-S	Soil	2.13E-05 ± 1.10E-05	µCi g^{-1} of dry soil
5-S	Soil	1.44E-05 ± 1.72E-05	µCi g^{-1} of dry soil
20-S	Soil	1.48E-05 ± 1.02E-05	µCi g^{-1} of dry soil
21-S	Soil	3.57E-05 ± 1.90E-05	µCi g^{-1} of dry soil
2-G	Grass	3.18E-04 ± 1.47E-04	µCi g^{-1} of dry ash
6-G	Grass	1.68E-04± 1.54E-04	µCi g^{-1} of dry ash
7-G	Grass	3.14E-04 ± 3.17E-04	µCi g^{-1} of dry ash
8-G	Grass	2.76E-04 ± 1.16E-04	µCi g^{-1} of dry ash
9-G	Grass	2.29E-04 ± 2.92E-04	µCi g^{-1} of dry ash
10-G	Grass	2.03E-04 ± 1.23E-04	µCi g^{-1} of dry ash
12-G	Grass	3.28E-04 ± 6.32E-05	µCi g^{-1} of dry ash
13-G	Grass	1.72E-04 ± 2.68E-04	µCi g^{-1} of dry ash
14-G	Grass	1.90-E04 ± 2.28E-04	µCi g^{-1} of dry ash
15-G	Grass	1.97E-04 ± 2.66E-04	µCi g^{-1} of dry ash
16-G	Grass	3.30E-04 ± 1.00E-04	µCi g^{-1} of dry ash
17-G	Grass	2.44E-04 ± 2.93E-04	µCi g^{-1} of dry ash
18-G	Grass	2.43E-04 ± 1.90E-04	µCi g^{-1} of dry ash
22-G	Grass	3.55E-04 ± 1.14E-04	µCi g^{-1} of dry ash

(1) ± values represent the standard deviation of the average value at the 95% confidence level.

(2) Less than lower limit of detection value shown.

Table V.E.4

Average Beta-Gamma LLD Concentration and Range of LLD Values for Soil, Water, and Vegetation Samples

Sample Type	Average LLD Value	Range of LLD Values	Reporting Units
Soil	7.64E-06	4.57E-06 *to* 1.31E-05	μCi g^{-1} of dry soil
Water	6.90E-08	5.79E-08 *to* 2.04E-07	μCi ml^{-1}
Vegetation	3.01E-05	6.91E-06 *to* 6.44E-05	μCi g^{-1} of dry ash

Table V.F.1

Annual Summary of Radioactive Material Shipments Originating From the TRIGA Reactor Facility's NRC License R-106

Shipped To	Total Activity (TBq)	Number of Shipments			
		Limited Quantity	Yellow II	Yellow III	Total
Berkeley Geochronology Center Berkeley, CA USA	7.41E-06	7	2	0	9
Cal State Fullerton Fullerton, CA USA	1.08E-06	2	0	0	2
California Institute of Technology Pasadena, CA USA	4.61E-06	1	0	0	1
Columbia University Palisades, NY USA	4.48E-06	4	0	0	4
Idaho State University Pocatello, ID USA	2.42E-04	0	14	0	14
Oregon State University Corvallis, OR USA	4.12E-05	0	4	0	4
Oregon State University Oceanography Department Corvallis, OR USA	5.91E-06	0	1	0	1
Plattsburgh State University Plattsburgh, NY USA	1.86E-06	2	0	0	2
Rutgers Piscataway, NJ USA	9.56E-07	2	0	0	2
Stanford University Stanford, CA USA	7.29E-06	4	0	0	4
Syracuse University Syracuse, NY USA	5.34E-07	1	0	0	1
Theragenics Corporation Buford, GA USA	1.82E-04	0	2	0	2
TruTec Services	1.20E-01	0	0	10	10
Union College Schenectady, NY USA	1.42E-06	2	0	0	2
University of California at Berkeley Berkeley, CA USA	1.04E-05	3	1	0	4

Table V.F.1 (continued)

Annual Summary of Radioactive Material Shipments Originating
From the TRIGA Reactor Facility's NRC License R-106

Shipped To	Total Activity (TBq)	Number of Shipments			
		Limited Quantity	Yellow II	Yellow III	Total
University of California at Santa Barbara Santa Barbara, CA USA	1.76E-06	3	0	0	3
University of Florida Gainesville, FL USA	4.32E-05	1	1	0	2
University of Geneva Geneva, SWITZERLAND	8.81E-07	1	0	0	1
University of Michigan Ann Arbor, MI USA	1.96E-04	1	29	0	30
University of Southern California Los Angeles, CA USA	5.64E-07	1	0	0	1
University of Washington Seattle, WA USA	2.82E-06	3	0	0	3
University of Wisconsin-Madison Madison, WI USA	6.64E-05	5	3	0	8
Totals	1.21E-01	43	57	10	110

Table V.F.2

Annual Summary of Radioactive Material Shipments Originating
From the Radiation Center's State of Oregon License ORE 90005

Shipped To	Total Activity (TBq)	Number of Shipments				
		LSA - 1	Limited Quantity	White I	Yellow II	Total
California Institute of Technology Pasadena, CA USA	6.28E-07	0	1	0	0	1
Lawrence Berkeley National Laboratory Berkeley, CA USA	1.85E-06	0	4	0	1	5
Michigan State University East Lansing, MI	1.85E-06	0	0	0	1	1
Oregon State University Corvallis, OR USA	2.78E-06	0	0	0	1	1
Yale University New Haven, CT USA	1.53E-09	0	1	0	0	1
Totals	7.11E-06	0	6	0	3	9

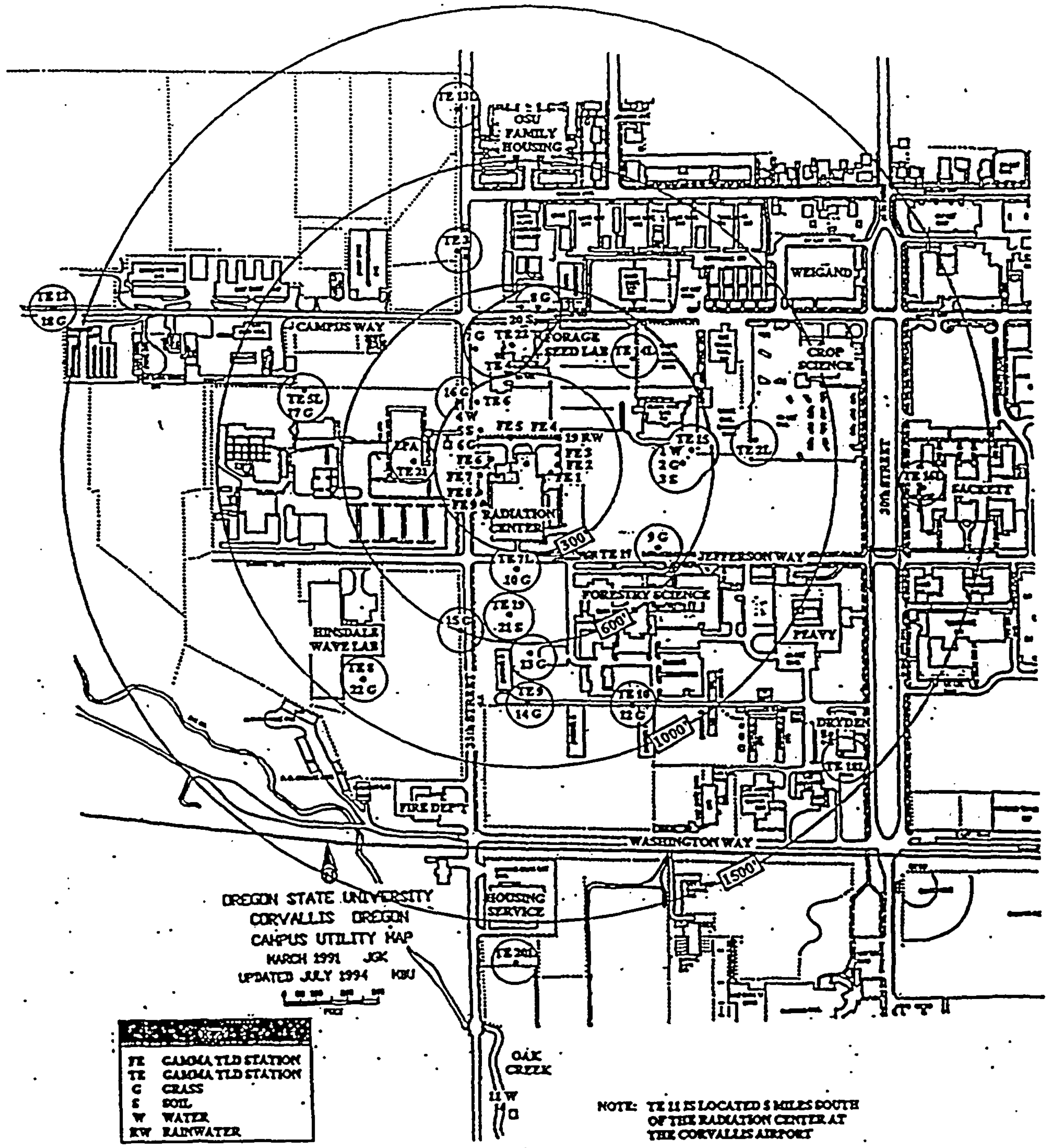
Table V.F.3

Annual Summary of Radioactive Material Shipments Exported
Under NRC General License 10 CFR 110.23

Shipped To	Total Activity (TBq)	Number of Shipments			
		Limited Quantity	Yellow II	Yellow III	Total
Freiburg University Zurich, Switzerland	5.07E-07	1	0	0	1
Polish Academy of Sciences Krakow, POLAND	2.83E-09	1	0	0	1
Ruhr-Universitat Bochum Bochum, GERMANY	1.82E-06	0	1	0	1
Scottish Universities Research and Reactor Centre East Kilbride, SCOTLAND	1.11E-06	1	0	0	1
Universita' Degli Studi di Bologna Bologna, ITALY	2.18E-06	4	0	0	4
Universitat Gottingen Gottingen, Germany	5.76E-08	1	0	0	1
Universitat Potsdam Postdam, GERMANY	2.10E-08	1	0	0	1
Universitat Tubingen Tubingen, GERMANY	6.95E-10	3	0	0	3
University of Manchester Manchester, UK	1.78E-06	2	0	0	2
Vrije Universiteit Amsterdam, THE NETHERLANDS	9.85E-07	1	0	0	1
Totals	8.47E-06	15	1	0	16

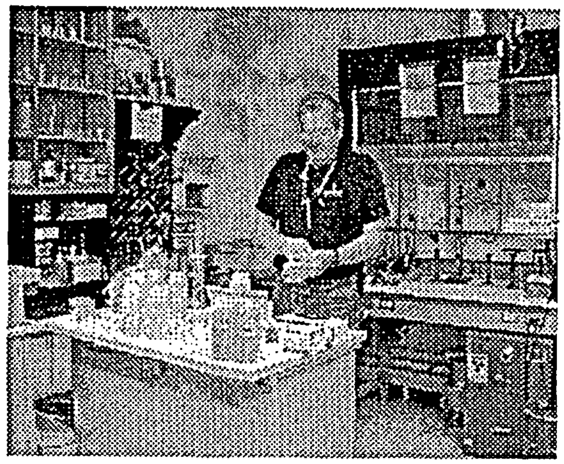
Figure V. D. 1

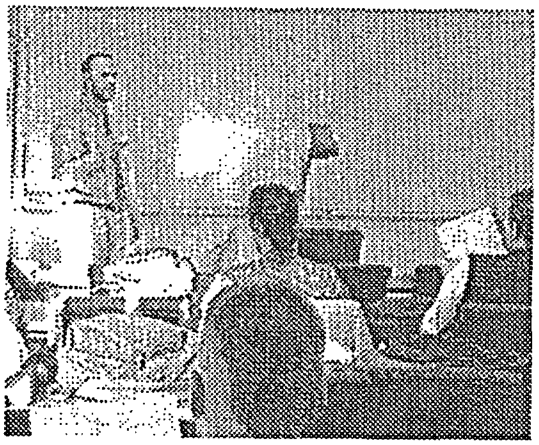
Monitoring Stations for the OSU TRIGA Reactor

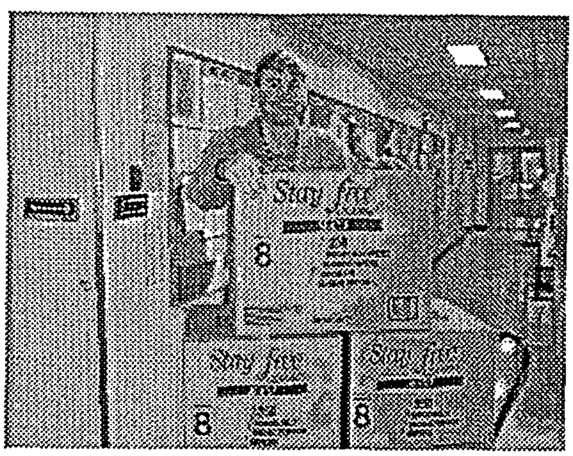


Part VI

Work







Part VI

WORK

A. Summary

The Radiation Center offers a wide variety of resources for teaching, research, and service related to radiation and radioactive materials. Some of these are discussed in detail in other parts of this report. The purpose of this part is to summarize the teaching, research, and service efforts carried out during the current reporting period.

B. Teaching

An important responsibility of the Radiation Center and the reactor is to support OSU's academic programs. Implementation of this support occurs through direct involvement of the Center's staff and facilities in the teaching programs of various departments and through participation in University research programs. Tables III.A.1 and III.D.1 plus Section VI.C.5 provide more detailed information on the use of the Radiation Center and reactor for instruction and training.

C. Research and Service

Almost all Radiation Center research and service work is tracked by means of a project database. When a request for facility use is received, a project number is assigned and the project is added to the database. The database includes such information as the project number, data about the person and institution requesting the work, information about students involved, a description of the project, Radiation Center resources needed, the Radiation Center project manager, status of individual runs, billing information, and the funding source.

Table VI.C.1 provides a summary of institutions which used the Radiation Center during this reporting period. This table also includes additional information about the number of academic personnel involved, the number of students involved, and the number of uses logged for each organization. Details on graduate student research which used the Radiation Center are given in Table VI.C.2.

The major table in this section is Table VI.C.3. This table provides a listing of the research and service projects carried out during this reporting period and lists information relating to the personnel and institution involved, the type of project, and the funding agency. Projects which used the reactor are indicated by an asterisk. In addition to identifying specific projects carried out during the current reporting period, Part VI also highlights major Radiation Center capabilities in research and service. These unique Center functions are described in Sections VI.C.1 through VI.C.8.

1. Neutron Activation Analysis

Neutron activation analysis (NAA) stands at the forefront of techniques for the quantitative multi-element analysis of major, minor, trace, and rare elements. The principle involved in NAA consists of first irradiating a sample with neutrons in a nuclear reactor such as the OSTR to produce specific radionuclides. After the irradiation, the characteristic gamma rays emitted by the decaying radionuclides are quantitatively measured by suitable semiconductor radiation detectors, and the gamma rays detected at a particular energy are usually indicative of a specific radionuclide's presence. Computerized data reduction of the gamma ray spectra then yields the concentrations of the various elements in samples being studied. With sequential instrumental NAA it is possible to measure quantitatively about 35 elements in small samples (5 to 100 mg), and for activable elements the lower limit of detection is on the order of parts per million or parts per billion, depending on the element.

The Radiation Center's NAA laboratory has analyzed the major, minor, and trace element content of tens of thousands of samples covering essentially the complete spectrum of material types and involving virtually every scientific and technical field.

While some researchers perform their own sample counting on their own or on Radiation Center equipment, the Radiation Center provides a complete NAA service for researchers and others who may require it. This includes sample preparation, sequential irradiation and counting, and data reduction and analysis.

Data on NAA research and service performed during this reporting period are included in Table VI.C.3.

2. Forensic Studies

Neutron activation analysis can also be advantageously used in criminal investigations. The principle underlying such application usually involves matching trace element profiles in objects or substances by NAA. This in turn can help identify materials or products (e.g., identify the manufacturer of a given object), and in some cases can match bullets and other materials recovered from a victim to similar materials obtained from suspects. Materials which have been analyzed by the Radiation Center for forensic purposes include bullets, metals, paint, fuses, coats, glass, meat, and salts.

Forensic studies performed in this reporting period are included in the listings in Tables VI.C.1 and VI.C.3.

3. Irradiations

As described throughout this report, a major capability of the Radiation Center involves the irradiation of a large variety of substances with gamma rays and neutrons. Detailed data on these irradiations and their use during this reporting period are included in Part III as well as in Section C of this part.

4. Radiological Emergency Response Services

The Radiation Center has an emergency response team capable of responding to all types of radiological accidents. This team directly supports the City of Corvallis and Benton County emergency response organizations and medical facilities. The team can also provide assistance at the scene of any radiological incident anywhere in the state of Oregon on behalf of the Oregon Radiation Protection Services and the Oregon Department of Energy.

The Radiation Center maintains dedicated stocks of radiological emergency response equipment and instrumentation. These items are located at the Radiation Center and at the Good Samaritan Hospital.

During the current reporting period, the Radiation Center emergency response team conducted several training sessions and exercises, but was not required to respond to any actual incidents.

5. Training and Instruction

In addition to the academic laboratory classes and courses discussed in Parts III.A.2, III.D, and VI.B, and in addition to the routine training needed to meet the requirements of the OSTR Emergency Response Plan, Physical Security Plan, and operator requalification program, the Radiation Center is also used for special training programs. Radiation Center staff are well experienced in conducting these special programs and regularly offer training in areas such as research reactor operations, research reactor management, research reactor radiation protection, radiological emergency response, reactor behavior (for nuclear power plant operators), neutron activation analysis, nuclear chemistry, and nuclear safety analysis.

Special training programs generally fall into one of several categories: visiting faculty and research scientists; International Atomic Energy Agency fellows; special short-term courses; or individual reactor operator or health physics training programs. During this reporting period there were a large number of such people as shown in Part II.B.

As has been the practice since 1985, Radiation Center personnel annually present a HAZMAT Response Team Radiological Course. This year the course was held at the Oregon State University Radiation Center.

6. Radiation Protection Services

The primary purpose of the radiation protection program at the Radiation Center is to support the instruction and research conducted at the Center. However, due to the high quality of the program and the level of expertise and equipment available, the Radiation Center is also able to provide health physics services in support of OSU Radiation Safety and to assist other state and federal agencies. The Radiation Center does not compete with private industry, but supplies health physics services which are not readily available elsewhere. In the case of support provided to state agencies, this definitely helps to optimize the utilization of state resources.

The Radiation Center is capable of providing health physics services in any of the areas which are discussed in Part V. These include personnel monitoring, radiation surveys, sealed source leak testing, packaging and shipment of radioactive materials, calibration and repair of radiation monitoring instruments (discussed in detail in Section VI.C.7), radioactive waste disposal, radioactive material hood flow surveys, and radiation safety analysis and audits.

The Radiation Center also provides services and technical support as a radiation laboratory to the State of Oregon Radiation Protection Services (RPS) in the event of a radiological emergency within the state of Oregon. In this role, the Radiation Center will provide gamma ray spectrometric analysis of water, soil, milk, food products, vegetation, and air samples collected by RPS radiological response field teams. As part of the ongoing preparation for this emergency support, the Radiation Center participates in inter-institution drills.

7. Radiological Instrument Repair and Calibration

While repair of nuclear instrumentation is a practical necessity, routine calibration of these instruments is a licensing and regulatory requirement which must be met. As a result, the Radiation Center operates a radiation instrument repair and calibration facility which can accommodate a wide variety of equipment.

The Center's scientific instrument repair facility performs maintenance and repair on all types of radiation detectors and other nuclear instrumentation. Since the Radiation Center's own programs regularly utilize a wide range of nuclear instruments, components for most common repairs are often on hand and repair time is therefore minimized.

In addition to the instrument repair capability, the Radiation Center has a facility for calibrating essentially all types of radiation monitoring instruments. This includes typical portable monitoring instrumentation for the detection and measurement of alpha, beta, gamma, and neutron radiation, as well as instruments designed for low-level environmental monitoring. Higher range instruments for use in radiation accident situations can also be calibrated in most cases. Instrument calibrations are performed using radiation sources certified by the National Institute of Standards and Technology (NIST) or traceable to NIST.

Table VI.C.4 is a summary of the instruments which were calibrated in support of the Radiation Center's instructional and research programs and the OSTR Emergency Plan, while Table VI.C.5 shows instruments calibrated for other OSU departments and non-OSU agencies.

8. Consultation

Radiation Center staff are available to provide consultation services in any of the areas discussed in this Annual Report, but in particular on the subjects of research reactor operations and use, radiation protection, neutron activation analysis, radiation shielding, radiological emergency response, and radiotracer methods.

Records are not normally kept of such consultations, as they often take the form of telephone conversations with researchers encountering problems or planning the design of experiments. Many faculty members housed in the Radiation Center have ongoing professional consulting functions with various organizations, in addition to sitting on numerous committees in advisory capacities.

9. Public Relations

The continued interest of the general public in the OSTR is evident by the number of people who have toured the facility. given during this reporting period. See Table VI.F.1 for statistics on scheduled visitors.

Table VI.C.1

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects[3]	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*Oregon State University[1] Corvallis, OR USA	25	23	6	52[2]
*Oregon State University - Educational Tours Corvallis, OR USA	15	13	0	27
AVI Bio Pharma Corvallis, OR USA	2	0	0	42
*Crescent Valley High School Corvallis, OR USA	2	1	0	2
*Evanite Fiber Corporation Corvallis, OR USA	1	0	0	1
*Linn Benton Community College Albany, OR USA	1	0	0	1
*Central Oregon Community College Bend, OR USA	1	1	0	1
* Falls City High School Falls City, OR USA	2	2	0	6
*Nunhems USA, Inc. Brooks, OR USA	1	1	0	16
*Philomath High School Philomath, OR USA	1	0	0	1
Providence St. Vincent Hospital Portland, OR USA	1	0	0	1
*Thurston High School Springfield, OR USA	1	1	0	1
*Idaho State University Pocatello, ID USA	2	2	0	9
*University of Washington Seattle, WA USA	1	1	0	3
*Berkeley Geochronology Center Berkeley, CA USA	1	0	4	12
*California Institute of Technology Pasadena, CA USA	2	1	0	17

Table VI.C.1 (continued)

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects[3]	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*California State University at Fullerton Fullerton, CA USA	2	2	2	3
M.K. Gems and Minerals Cerritos, CA USA	1	0	0	1
*Stanford University Stanford, CA USA	2	2	0	5
*Tru-Tee Merced, CA USA	1	0	0	2
* University of California at Berkeley Berkeley, CA USA	3	3	1	4
*University of California at Santa Barbara Santa Barbara, CA USA	2	3	5	3
*University of Southern California Los Angeles, CA USA	1	1	0	1
*University of Wyoming Laramie, WY USA	1	1	0	1
*Geovic, Ltd. Grand Junction, CO USA	1	0	0	2
*University of Houston Houston, TX USA	2	2	2	2
*University of Wisconsin Madison, WI USA	2	2	5	14
*University of Michigan Ann Arbor, MI USA	3	3	0	31
*Theragenics Corporation Buford, GA USA	1	0	0	2
*Columbia University Palisades, NY USA	2	2	0	4
*George Washing University Washington, DC USA	1	1	0	1
*North Carolina State University Raleigh, NC USA	2	1	0	1
*Plattsburgh State University Plattsburg, NY USA	2	2	0	2

Table VI.C.1 (continued)

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects[3]	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*Syracuse University Syracuse, NY USA	2	2	3	2
*Union College Schenectady, NY USA	2	2	0	2
*Rutgers Piscataway, NJ USA	3	3	2	3
Arch Chemicals Inc. Cheshire, CT USA	1	1	0	5
*University of Florida Gainesville, FL USA	1	1	0	2
Vectron International Norwalk Inc. Norwalk, CT USA	1	0	0	5
*University of Manchester Manchester, UK	1	1	1	3
*Universite Paris-Sud Paris, FRANCE	1	1	0	1
*Vrije Universiteit Amsterdam, THE NETHERLANDS	1	1	4	3
*Albert-Ludwigs-Universitaet Freiburg, GERMANY	1	0	1	1
*Polish Academy of Sciences Krakow, POLAND	1	0	0	1
*Ruhr-Universitat Bochum Bochum, GERMANY	2	2	0	1
*Universita' Degli Studi di Bologna Bologna, ITALY	1	2	0	1
*Universita' di Bologna Bologna, ITALY	1	1	0	3
*Unversitat Potsdam Potsdam, GERMANY	1	0	0	1
*University of Geneva Geneva, SWITZERLAND	1	1	0	1
*University of Goettingen Gottingen, GERMANY	1	1	3	4

Table VI.C.1 (continued)

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects(3)	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*University of Tuebingen Tuebingen, GERMANY	1	1	0	2
*University of Queensland Brisbane, Queensland AUSTRALIA	1	1	0	2
Total	113	92	39	325

* Project which involves the OSTR

(1) Use by Oregon State University does not include any teaching activities or classes accommodated by the Radiation Center.

(2) This number does not include ongoing projects being performed by residents of the Radiation Center such as the APEX project, others in the Department of Nuclear Engineering or Department of Chemistry, or projects conducted by Dr. W. D. Loveland, which involve daily use of Radiation Center facilities.

(3) This does not include projects pertaining to instrument calibrations.

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Albert-Ludwigs-Universitaet					
Link, Katharina	PhD	Mineralogy	Rahn	1595	Fission track dating of Mid-European Rhine graben shoulder uplift
Berkeley Geochronology Center					
Culler, Timothy	PhD	Earth and Planetary Science	Alvarez	920	Lunar Impact History from Analysis of Impact Melt Spherules
Knight, Kimberly	MA	Earth and Planetary Science	Renne	920	Geochemical and Isotopic Insights into Continental Flood Basalts
Kyoungwon, Min	MA	Earth and Planetary Science	Renne	920	Reduction of Systematic Errors in 40Ar/39Ar Geochronology
Zhou, Zhensheng	MA	Earth and Planetary Science	Renne	920	Rates and Tempo of Permian-Triassic Boundary Events.
California State University at Fullerton					
Irwin, Christine	MS	Geological Sciences	Armstrong	1625	Uplift of the Puente Hills using fission track data
Oregon State University					
Ashbaker, Eric	MS	Nuclear Engineering and Radiation Health Physics	Reese	1702	Determination of neutron flux and spectrum in various OSTR irradiation facilities
Huang, Zhongliang	PhD	Chemistry	Loveland	1598	
Sinton, Christopher	PhD	Oceanography	Duncan	444	Age and Composition of Two Large Igneous Provinces: The North Atlantic Volcanic Rifted Margin and the Caribbean Plateau
Rutgers					
Mollel, Godwin	PhD	Geological Sciences	Turrin	1707	Statigraphy and Chronolgy of the Plio-Plaeistocene Ngorongoro Volcanic Highland

Table VI.C.2 (continued)

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Young, Amy	PhD	UCLA Geology	Turrin	1423	Petrology and geochemical evolution of the Damavand trachyandesite volcano in northern Iran.
Scottish Universities Research and Reactor Centre					
Barry, T.	PhD	Leicester University	Pringle	1073	Mongolian Basalts/Tectonics
Blecher, J.	PhD	Oxford University	Pringle	1073	Aden Volcanic Differentiation
Carn, S.	PhD	Cambridge University	Pringle	1073	Indonesian Volcanics
Chambers, L.	PhD	Edinburgh University	Pringle	1073	North Atlantic Tertiary Province
Dixon, H.	PhD	Bristol University	Pringle	1073	Subglacial Volcanics
Harford, C.	PhD	Bristol University	Pringle	1073	Montserrat Volcanic Hazards
Heath, E.	PhD	Lancaster University	Pringle	1073	St. Vincent Volcano Hazards
May, G.	PhD	Aberdeen University	Pringle	1073	Chilean Basins
McElderry, S.	PhD	Liverpool University	Pringle	1073	Chilean Tertiary Faulting
Najman, Y.	PhD	Edinburgh University	Pringle	1073	Himalayan Foredeep
Purvis, M.	PhD	Edinburgh University	Pringle	1073	Turkish Basin Tectonics

Table VI.C.2 (continued)

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Shelton, R.	PhD	Queens University	Pringle	1073	North Channel Basin Evolution
Sowerbutts, A.	PhD	Edinburgh University	Pringle	1073	Sardinia Evolution
Steele, G.	PhD	Aberdeen University	Pringle	1073	Cerro Rico Silver
White, R.	PhD	Leicester University	Pringle	1073	Caribean Crustal Growth
Syracuse University					
Kline, Simon	MS	Earth Sciences	Fitzgerald	1555	Uplift of the Transantarctic Mountains in the Reedy Glacier area
Monteleone, Brian	PhD	Earth Sciences	Fitzgerald	1555	Papua New Guinea Woodlark Basin Project
Schwabe, Erika	PhD	Earth Sciences	Fitzgerald	1555	Exhumation in the western Pyrenees
University of California at Berkeley					
Herbison, Sarah	PhD	Department of Chemistry	Nitsche	1468	
University of California at Santa Barbara					
Calvert, Andy	PhD	Geological Sciences	Gans	1020	Tectonic Studies in Eastern-Most Russia
Nauert, Jon	MS	Geological Sciences	Gans	1020	Volcanism in the Eldorado Mountains, Southern Nevada
University of Goettingen					
Angelmaier, Petra	PhD	Institut fur Geologie und Palaotologie	Dunkl	1519	Exhumation path of different tectonic blocks along the central part of the Transalp-Traverse (Eastern Alps).

Table VI.C.2 (continued)

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Most, Thomas	PhD	Institut fur Geologie und Palaontologie	Dunkl	1519	Mesozoic and Tertiary Tectonometamorphic Evolution of Pelagonian Massif
Schwab, Martina	PhD	Institut fur Geologie und Palaontologie	Dunkl	1519	Thermochronology and Structural Evolution of Pamir Mts.
University of Manchester					
Flude, Stephanie	PhD	Earth Sciences	Burgess	1592	Rhyolite volcanism in Iceland: timing and timescales of eruption
University of Wisconsin					
Barquero-Molina, Miriam	PhD	Geology and Geophysics	Singer	1612	
Harper, Melissa	MS	Geology and Geophysics	Singer	1612	
Jicha, Brian	MS	Geology and Geosciences	Singer	1465	
Jicha, Brian	MS	Geology and Geophysics	Singer	1612	
Relle, Monica	MS	Geology and Geophysics	Singer	1465	
Vrije Universiteit					
Beintema, Kike	PhD	Department of Structural Geology	White/Wijbrans	1074	The Kinematics and Evolution Major Structural Units of the Archean Pilbara Craton, Western Australia
Carrapa, Barbara	MA	Isotope Geochemistry	Wijbrans/Bertotti	1074	The tectonic record of detrital minerals on sun-orogenics clastic sediments
Kuiper, Klaudia	PhD	Isotope Geochemistry	Hilgen/Wijbrans	1074	Intercalibration of astronomical and radioisotopic timescales

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
444	Duncan	Oregon State University	Ar-40/Ar-39 Dating of Oceanographic Samples	Production of Ar-39 from K-39 to measure radiometric ages on basaltic rocks from ocean basins.	OSU Oceanography Department
481	Le	Oregon Health Sciences University	Instrument Calibration	Instrument calibration.	Oregon Health Sciences University
488	Farmer	Oregon State University	Instrument Calibration	Instrument calibration.	OSU Radiation Center
519	Martin	US Environmental Protection Agency	Instrument Calibration	Instrument calibration.	USEPA-Corvallis
547	Boese	US Environmental Protection Agency	Survey Instrument Calibration	Instrument calibration.	USEPA, Cincinnati, OH
664	Reese	Oregon State University	Good Samaritan Hospital Instrument Calibration	Instrument calibration.	OSU Radiation Center
815	Morrell	Oregon State University	Sterilization of Wood Samples	Sterilization of wood samples to 2.5 Mrads in Co-60 irradiator for fungal evaluations.	OSU Forest Products
920	Becker	Berkeley Geochronology Center	Ar-39/Ar-40 Age Dating	Production of Ar-39 from K-39 to determine ages in various anthropologic and geologic materials.	Berkeley Geochronology Center
930	McWilliams	Stanford University	Ar-40/Ar-39 Dating of Geological Samples	Irradiation of mineral grain samples for specified times to allow Ar-40/Ar-39 dating.	Stanford University Geological & Environmental Sci
932	Dumitru	Stanford University	Fission Track Dating	Thermal column irradiation of geological samples for fission track age-dating.	Stanford University Geology Department

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1018	Gashwiler	Occupational Health Lab	Calibration of Nuclear Instruments	Instrument calibration.	Occupational Health Laboratory
1020	Gans	University of California at Santa Barbara	Tectonic Studies in Eastern-Most Russia	Irradiation for Ar-40/Ar-39 dating using the CLICIT or dummy fuel element.	National Science Foundation
1072	Markos	Army Corps of Engineers	Instrument Calibration	Instrument calibration.	U.S. Army Engineer District, Portland.
1073	Pringle	Scottish Universities Research and Reactor Centre	Argon 40/39 Dating of Rock Minerals	Age dating of various materials using the Ar-40/Ar-39 ratio method.	Scottish Universities Research and Reactor Centre
1074	Wijbrans	Vrije Universiteit	40Ar-39 Ar Dating of Rocks and Minerals	40Ar-39Ar dating of rocks and minerals.	Vrije Universiteit, Amsterdam
1075	Teaching and Tours	University of California at Berkeley	Activation Analysis Experiment for NE Class	Irradiation of small, stainless steel discs for use in a nuclear engineering radiation measurements laboratory.	University of California at Berkeley
1118	Larson	Oregon State University	Primary Phytoplankton Production Studies at Crater Lake	Evaluation of the primary production of phytoplankton in Crater Lake and lakes in Mount Rainier, Olympic, and North Cascades National Parks.	US Geological Survey
1188	Salinas	Rogue Community College	Photoplankton Growth in Southern Oregon Lakes	C-14 liquid scintillation counting of radiotracers produced in a photoplankton study of southern Oregon lakes: Miller Lake, Lake of the Woods, Diamond Lake, and Waldo Lake.	Rogue Community College

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1191	Vasconcelos	University of Queensland	Ar-39/Ar-40 Age Dating	Production of Ar-39 from K-39 to determine ages in various anthropologic and geologic materials.	Earth Sciences, University of Queensland
1267	Hemming	Columbia University	Geochronology by Ar/Ar Methods	Snake River plain sanidine phenocrysts to evaluate volcanic stratigraphy; sandine and biotite phenocrysts from a late Miocene ash, Mallorca to more accurately constrain stratigraphic horizon; hornblends and feldspar from the Amazon to assess climatic changes and differences in Amazon drainage basin provenance.	Columbia University
1354	Wright	Radiation Protection Services	Radiological Instrument Calibration	Instrument calibration.	State of Oregon Radiation Protection Services
1366	Quidelleur	Universite Paris-Sud	Ar-Ar Geochronology	Determination of geological samples via Ar-Ar radiometric dating.	Universite Paris-Sud
1397	Teach	Providence St. Vincent Hospital	Sterilization of various biological materials	Sterilization of various biological materials for St. Vincents Hospital, Portland	Oregon Medical Laser Institute
1406	Pate	Tracerco	Production of Argon-41	Production of Argon-41 for various field uses	Tracerco
1415	McGinness	ESCO Corporation	Calibration of Instruments	Instrument calibration	ESCO Corporation
1423	Turrin	Rutgers	40Ar/39Ar Analysis	Petrology and geochemical evolution of the Damavand trachyandesite volcano in Northern Iran.	Department of Geological Sciences

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1430	Bottomley	Oregon State University	Atrazine Remediation in a Wetland Environment	Characterization of fate of atrazine in wetland mesocoms and a constructed wetland; investigation of presence of atrazine degrading microorganisms in rhizosphere soil.	OSU Microbiology Department
1431	Patterson	AVI Bio Pharma	Instrument Calibrations	Instrument calibration	AVI Bio Pharma
1464	Slavens	USDOE Albany Research Center	Instrument Calibration	Instrument calibration.	USDOE Albany Research Center
1465	Singer	University of Wisconsin	Ar-40/Ar-39 Dating of Young Geologic Materials	Irradiation of geological materials such as volcanic rocks from sea floor, etc. for Ar-40/Ar-39 dating.	University of Wisconsin
1467	Kirner	Kirner Consulting, Inc	Instrument Calibration	Instrument calibration.	Kirner Consulting
1468	Nitsche	University of California at Berkeley	Chemistry 146 Experiment	Sample irradiations for Chemistry 146 class	University of California at Berkeley
1470	Bolken	SIGA Technologies, Inc.	Instrument Calibration	Instrument calibration.	Siga Pharmaceuticals
1479	Paul	Oregon State University	Biological Toxin Sensor	Multidisciplinary development of a biological toxin sensor using arethrophore cells for the Defense Advanced Research Projects Agency.	OSU Industrial & Manufacturing Engineering

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1489	Roden-Tice	Plattsburgh State University	Thermochronologic evidence linking Adirondack and New England regions Connecticut Valley Regions	The integration of apatite fission-track ages and track length based model thermal histories, zircon fission-track ages, and U-Th/He analyses to better define the pattern of regional post-Early Cretaceous differential unroofing in northeastern New York's Adirondack region and adjacent western New England.	Plattsburgh State University
1492	Stiger	Federal Aviation Administration	Instrument Calibration	Instrument calibration	Federal Aviation Administration
1502	Teaching and Tours	Portland Community College	Portland Community College Tours/Experiments	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1503	Teaching and Tours	Non-Educational Tours	Non-Educational Tours	Tours for guests, university functions, student recruitment.	OSU Radiation Center
1504	Teaching and Tours	Oregon State University - Educational Tours	OSU Nuclear Engineering & Radiation Health Physics Department	OSTR tour and reactor lab.	USDOE Reactor Sharing
1505	Teaching and Tours	Oregon State University - Educational Tours	OSU Chemistry Department	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1506	Teaching and Tours	Oregon State University - Educational Tours	OSU Geosciences Department	OSTR tour.	USDOE Reactor Sharing
1507	Teaching and Tours	Oregon State University - Educational Tours	OSU Physics Department	OSTR tour.	USDOE Reactor Sharing
1508	Teaching and Tours	Oregon State University - Educational Tours	Adventures in Learning Class	OSTR tour.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1509	Teaching and Tours	Oregon State University - Educational Tours	HAZMAT course tours	First responder training tours.	Oregon Office of Energy
1510	Teaching and Tours	Oregon State University - Educational Tours	Science and Mathematics Investigative Learning Experience	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1511	Teaching and Tours	Oregon State University - Educational Tours	Reactor Staff Use	Reactor operation required for conduct of operations testing, operator training, calibration runs, encapsulation tests and other.	OSU Radiation Center
1512	Teaching and Tours	Linn Benton Community College	Linn Benton Community College Tours/Experiments	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1514	Sobel	Universitat Potsdam	Apatite Fission Track Analysis	Age determination of apatites by fission track analysis.	Universitat Potsdam
1519	Dunkl	University of Goettingen	Fission Track Analysis of Apatites	Fission track dating method on apatites: use of fission tracks from decay of U-238 and U-235 to determine the cooling age of apatites.	University of Tuebingen
1520	Teaching and Tours	Western Oregon University	Western Oregon University	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1522	Control Room	Oregon State University	General Reactor Operation	Reactor operation when no other project is involved.	OSU Radiation Center
1523	Zattin	Universita' Degli Studi di Bologna	Fission track analysis of apatites	Fission track analysis of apatites.	Universita' Degli Studi di Bologna
1524	Thomson	Ruhr-Universitat Bochum	Fission track analysis of apatites and zircon	Fission track analysis of apatites and zircon.	Ruhr-Universitat Bochum
1525	Teaching and Tours	Life Gate High School	Life Gate High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1526	Crawford	Hot Cell Services	Instrument calibration	Instrument calibration.	Hot Cell Services
1527	Teaching and Tours	Oregon State University - Educational Tours	Odyssey Orientation Class	OSTR tour.	USDOE Reactor Sharing
1528	Teaching and Tours	Oregon State University - Educational Tours	Upward Bound	OSTR tour.	USDOE Reactor Sharing
1529	Teaching and Tours	Oregon State University - Educational Tours	OSU Connect	OSTR tour.	USDOE Reactor Sharing
1530	Teaching and Tours	Newport School District	Newport School District	OSTR tour.	USDOE Reactor Sharing
1531	Teaching and Tours	Central Oregon Community College	Central Oregon Community College Engineering	OSTR tour.	USDOE Reactor Sharing
1535	Teaching and Tours	Corvallis School District	Corvallis School District	OSTR tour.	USDOE Reactor Sharing
1536	Nuclear Engineering Faculty	Oregon State University	Gamma Irradiations for NE/RHP 114/115/116	Irradiation of samples for Introduction to Nuclear Engineering and Radiation Health Physics courses NE/RHP 114/115/116.	OSU Radiation Center
1537	Teaching and Tours	Oregon State University - Educational Tours	Naval Science Department	OSTR tour.	USDOE Reactor Sharing
1538	Teaching and Tours	Oregon State University - Educational Tours	OSU Speech Department	OSTR tour.	USDOE Reactor Sharing
1539	Most	Universitat Tubingen	Fission track studies	Age dating by the fission track method.	Universitat Tubingen

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1540	Teaching and Tours	McKay High School	McKay High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1542	Teaching and Tours	Oregon State University - Educational Tours	Engineering Sciences Classes	OSTR tour.	USDOE Reactor Sharing
1543	Bailey	Veterinary Diagnostic Imaging & Cytopathology	Instrument Calibration	Instrument calibration.	Veterinary Diagnostic Imaging & Cytopathology
1544	Teaching and Tours	West Albany High School	West Albany High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1545	Teaching and Tours	Oregon State University - Educational Tours	OSU Educational Tours	OSTR tour.	USDOE Reactor Sharing
1548	Teaching and Tours	Willamette Valley Community School	Willamette Valley Community School	OSTR tour.	USDOE Reactor Sharing
1555	Fitzgerald	Syracuse University	Fission track thermochronology	Irradiation to induce U-235 fission for fission track thermal history dating, especially for hydrocarbon exploration. The main thrust is towards tectonics, in particular the uplift and formation of mountain ranges.	Syracuse University
1558	Binney	Oregon State University	Measurement of cross sections for medical radionuclides	Irradiations to measure neutron cross sections for medically important radionuclides.	USDOE
1564	Krane	Oregon State University	Measurement of neutron capture cross sections	Measurement of neutron capture cross sections.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1567	Johnson	University of Houston	Compositions of apatites from magnetite-rich segregation deposits in the Cornucopia stock, NE Oregon	Study of chemical composition of apatites from magnetite deposits in Cornucopia stock to determine processes responsible for their genesis.	USDOE Reactor Sharing
1571	Hansen	Geological Institute	Fission track analysis	Study of East Greenland contionental margin to determine thermotectonic evolution as an aid in understanding rifting and opening of a continental volcanic margin with formation of a new ocean.	Geological Institute
1573	Baxter	California Institute of Technology	Ar partitioning experiments	Measurement of the partitioning of noble gases between crystals and grain boundaries.	California Institute of Technology
1578	Monie	University of Montpellier	Fission Track Analysis of U-235	Use of fission tracks from U-235 to determine the uranium content in minerals.	University of Montpellier
1579	Leisy	Oregon State University	Irradiation of Bacillus Spores	Immunization of fish with Bacillus subtilis spores and challenged with virulent infectious hematopoietic necrosis virus (IHNV) to test for immunization against IHNV.	OSU Microbiology Department
1583	Teaching and Tours	Neahkahnie High School	Neahkahnie High School	OSTR tour.	USDOE Reactor Sharing
1584	Teaching and Tours	Reed College	Reed College Staff & Trainees	OSTR tour.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress
at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1592	Burgess	University of Manchester	Ar-Ar dating of Icelandic rhyolites	Nuclear irradiation of rock chips in cadmium-lined irradiation facility for Ar-Ar dating studies of Icelandic rhyolites.	University of Manchester
1594	Teaching and Tours	Jefferson High School	Jefferson High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1595	Rahn	Albert-Ludwigs-Universitaet	Fission Track Dating of the Mid-European Rhine Graben Shoulder	Dating of the shoulder uplift along the Mid-European Rhine graben shoulders by the fission track technique.	German Science Foundation
1598	Loveland	Oregon State University	QSAR of organically bound metals	Measurement of octanol/water partition coefficients for a series of chemically related organically bound metals.	OSU Chemistry Department
1601	Crutchley	Josephine County	Instrument Calibrations	Instrument calibration.	Josephine County Public Works
1602	Teaching and Tours	Crescent Valley High School	Crescent Valley High School AP Physics Class	Investigation of arsenic concentrations in soils and bedrock of the Sweet Home area.	USDOE Reactor Sharing
1603	Teaching and Tours	Thurston High School	Thurston High School Chemistry	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1604	Buckovic	Geovic Ltd.	Support of Cobalt-Nickel Laterite Analyses	Analysis of Co/Ni in soil samples from Africa.	Geovic, Ltd.

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress
at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1607	Struzik	Polish Academy of Sciences	Timing of uplift and exhumation of Polish Western Carpathians	Determination of timing of uplift and exhumation of Polish Western Carpathians (Tatra Mts. and Podhale Flysch) using AFT methods to verify paleotemperature, which are determined by illite-smectite methods. Reconstruction of thermal history.	Polish Academy of Sciences
1611	Teaching and Tours	Grants Pass High School	Grants Pass High School	OSTR tour.	USDOE Reactor Sharing
1612	Singer	University of Wisconsin	Determination of age of Eocene and Quaternary volcanic rocks	Determination of age of Eocene and Quaternary volcanic rocks by production of Ar-39 from K-39.	USDOE Reactor Sharing
1613	Teaching and Tours	Silver Falls School District	Silver Falls School District	OSTR tour.	USDOE Reactor Sharing
1614	Teaching and Tours	Marist High School	Marist High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1615	Teaching and Tours	Liberty Christian High School	Liberty Christian High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1616	Doyle	Evanite Fiber Corporation	Instrument Calibration	Instrument calibration.	Evanite Fiber Corporation
1617	Spikings	University of Geneva	Ar-Ar geochronology	Argon dating of Chilean granites.	University of Geneva
1618	Teaching and Tours	Falls City High School	Fall City High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1619	Teaching and Tours	Sheridan High School	Sheridan High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1620	Teaching and Tours	Eddyville High School	Eddyville High School	OSTR tour.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1621	Foster	University of Florida	Irradiation for Ar/Ar Analysis	Ar/Ar analysis of geological samples.	University of Florida
1622	Reese	Oregon State University	Flux Measurements of OSTR	Measurement of neutron flux in various irradiation facilities.	OSU Radiation Center
1623	Blythe	University of Southern California	Fission Track Analysis	Fission track Thermochronology of Tibetian Geology	University of Southern California
1625	Armstrong	California State University at Fullerton	Fission Track Irradiations	Measurement of fission track ages to determine erosion amounts and timing.	USDOE Reactor Sharing
1627	Fleischer	Union College	Fission Track Irradiations	The primary project is the use of tracks to study the leaching out of imbedded radionuclides from alpha-activity in materials. The radionuclide could be a decay product of U-238 or Th-232 in studying the geochemistry of natural materials, or of Rn-222 in dealing with environmental materials that are used to assess radon exposures. Here we will use an analogue case – the embedding in the laboratory of U-235 recoils from the alpha activity of Pu-239.	USDOE Reactor Sharing
1628	Garver	Union College	Fission Track Irradiations	Use of fission track to determine age dating of apatites.	USDOE Reactor Sharing
1629	Rauch	Nu-Trek, Inc	GaAs 1 MeV Equivalent Damage Evaluation	Neutron damage to GaAs to reduce carrier lifetime to make flash x-ray photoconductive detectors	Nu-Trek, Inc.

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1633	Goles	University of Oregon	Evolution and lateral growth of active continental margins	Selected terranes of the New Zealand basement contain metasediments that are ideal for testing the model and learning about the evolution of this part of the ancient Gondwana active margin; clasts of terrane conglmerates will be characterized by INAA.	USDOE Reactor Sharing
1634	Tollo	George Washington University	REE Geochemistry of Meta-Igneous Rocks using INAA (TBC)	NAA of apatite samples to determine metal composition in ingneous rocks.	USDOE Reactor Sharing
1635	Fodor	North Carolina State University	Geologic NAA	Determination of rare earth elements in ultramafic rocks by NAA	USDOE Reactor Sharing
1637	Johnson	University of Houston	Geochemistry of gold bearing horblendite vains	Geochemical analysis of golde hornblendite veins that are gold mineralized and part of a larger porphyry copper stock.	USDOE Reactor Sharing
1638	Lee	University of Oregon	Geochemistry of lithological matter to determine provenance	Relationships bewteen regional geologic features can be contraint by the geochemical analysis of rocks in formations.	USDOE Reactor Sharing
1640	Gans	University of California at Santa Barbara	Age dating of Neogene volcanism	Age dating of rock samples from Sierra Nevada, Sonora, Mexico, and Chilean Andes	USDOE Reactor Sharing
1641	Hughes	Idaho State University	Independent Study of NAA	Development of NAA for Thesis Research	USDOE Reactor Sharing
1643	York	York Engineering	INAA of Paint Scrapings	Determination of the chemical composition of paint scrapings from marine vessels as a potential identification technique.	York Engineering

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1645	Gustafson	Oregon State University	Pulmonic and Vascular Repair with Biomaterial Patch	Creation of biomaterial to repair an induced lung injury in rabbits.	OSU Veterinary Medicine
1646	Schutfort	Oregon State University	Verification of NIST SRM standards	The purpose of this project is to verify NIST SRM standard reference materials used in neutron activation analysis projects at Oregon State University.	
1647	Graefe	GeoForschungsZentrum Potsdam	Fission Track Irradiations	Use of fission track to study zircon.	GeoForschungsZentrum Potsdam
1648	Stewart	University of Washington	Fission-track Dating of Zircon	Fission-track Dating of Zircon from the Exhumation of Avaloatz Mountians in California	University of Washington
1652	Haucke	Intel	Determination of Trace Impurities in High-purity Germanium	The objective of this project is to determine trace impurities (Al, Mg, Na, Ga) in high purity germanium crystals.	Intel Corporation
1653	Teaching and Tours	Madison High School	Madison High School Senior Science Class	OSTR tour.	USDOE Reactor Sharing
1655	Teaching and Tours	Future Farmers of America	OSTR Tour	OSTR tour	USDOE Reactor Sharing
1656	Mourich	AVI Bio Pharma	Avasive anitcancer vaccine mechanism of immuno-protein	Using a mouse model for cancer. Tumor cells are irradiated and then coated with anitbodies produced by the vaccine. This complex is use to vaccinate mice to determine if subsequent anti-tumor specific immune responses are generated.	AVI Bio Pharma
1657	Teaching and Tours	Richland High School	Richland High School	OSTR tour.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1658	Hensel	Hemcon, Inc.	Sterilization of Bandages	Sterilization of Army bandages used for hemorrhage control.	Hemcon Inc.
1660	Reese	Oregon State University	Isotope and Container Testing	Testing of containers and source material	
1661	Wroblewski	Vectron International Norwalk Inc.	Gamma Irradiation of Parts	Gamma irradiation of parts.	Vectron International
1662	Retallack	University of Oregon	Geochemistry of Soil from Eugene Hills	Determination of the trace element chemistry of soils.	USDOE Reactor Sharing
1664	Ciarella	Providence Medical Center	Determination of Gadolinium in Spinal Cord Fluid	Neutron Activation Analysis of spinal cord fluid and Omniscan RX (gadodiamine) for gadolinium after radiochemical separation of sodium on HAP.	OSU Radiation Center
1665	LaFleur	National Council of Stream and Air Improvement	Preparation of Hog Fuel Standard Reference Material	Preparation of an NAA standard of composite wood waste material as a reference material for laboratory analyses.	National Council for Air & Stream Improvement
1666	Teaching and Tours	Douglas High School	Douglas High School AP Physics Class	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1668	Meigs	Oregon State University	Fission Track Dating	Use of fission tracks from U-235 to determine the locationand concentration of U238 in apatite/zircon crystals for age dating	USDOE Reactor Sharing
1669	Hamby	Oregon State University	Activation of Black Beans	Activation of black beans used as a natural tracer in laboratory animal nutrition studies	USDOE Reactor Sharing

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress
at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1670	Teaching and Tours	Toledo High School	Toledo High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1671	Roden-Tice	Plattsburgh State University	Fission Track Dating	Use of fission tracks to determine location of U-235 and Th232 in natural rocks and minerals	USDOE Reactor Sharing
1672	Brix	Ruhr-Universitat Bochum	Fission track analysis of apatites and zircon.	Fission track analysis of apatites and zircon.	Ruhr-Universitat Bochum
1673	Teaching and Tours	Heal College	Heal College Physics Department	OSTR tour.	USDOE Reactor Sharing
1674	Niles	Oregon Office of Energy	Radiological Emergency Support	Radiological emergency support ot OOE related to instrument calibration, radiological and RAM transport consulting, and maintenance of radiological analysis laboratory at the Radiation Center.	Oregon Department of Energy
1675	Ho	Oregon State University	Zinc in Oxidative Stress and DNA Integrity	Determining the biological responses to low dose ionizing radiation and their interaction with nutrition.	
1676	Minc	University of Michigan	NAA of labelled antibodies	Au labelled antibodies are used use in cancer studies. NAA tracks the presence of the antibodies in various organs.	University of Michigan
1677	Zuffa	Universita' di Bologna	Fission Track Dating	Use of fission track from U-235 to determine uranium content in rock	Universita' di Bologna
1678	Sivaramakrishnan	Oregon State University	Gamma Irradiations	Gamma irradiation of electronic components	OSU Electrical & Computing Engineering

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1679	Miyahira	California Institute of Technology	Neutron Damage on Electronics	Iterative irradiations to test the effects of neutron damage upon various electronic components	Jet Propulsion Laboratory
1680	Danisik	Unversity of Tubingen	Fission Track Dating	Low-temperature geochronology using He and fission track dating.	University of Tuebingen
1681	Yang	University of Michigan	Detection of Metals in Zeolite Catalysts	Use of NAA to detect various metals in zeolite catalysts and sorbents.	USDOE Reactor Sharing
1682	Devi	AVI Bio Pharma	Effect of Gamma Radiation on the Expression of XIAP in Prostate and Lung Cancer Cells	Effect of gamma radiation on the expression of XIAP in prostate and lung cancer cells.	AVI Bio Pharma
1683	Bennion	Idaho State University	Nuclear Engineering Pulsing Lab		USDOE Reactor Sharing
1684	Fodor	North Carolina State University	Geochemical Investigation		USDOE Reactor Sharing
1685	Dick	Oregon State University	short-stay Belen ph vs heavy metals experiment	Gamma irradiation of soils.	OSU Crop and Soil Science
1686	Miller	Nunhems USA, Inc.	Production of haploid and dihaploid melon plants induced with irradiated pollen	Irradiated melon pollen will be used to polliate female melon plants to induce parthenogenetic embryos. These embryos will be rescued and cultured for plant production.	Sunseeds
1687	Teaching and Tours	Inavale Grade School	Reactor Tour	General reactor tour	USDOE Reactor Sharing
1688	Moore	Northwest Construction Surveying & Testing	Instrument Calibration	Instrument calibration	Northwest Construction Surveying & Testing

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1689	Gardner	Oregon State University	Count Gamma Rays from 181Hf		USDOE Reactor Sharing
1690	Teaching and Tours	Wilson High School	Reactor Tour	D300 Reactor Tour	USDOE Reactor Sharing
1691	Teaching and Tours	Lost River High School	Reactor Tour	D300 Reactor Tour	USDOE Reactor Sharing
1692	Choi	Arch Chemicals Inc.	Screening Tests of Wood Decay	This is to build up basic knowledge on the efficacy of a copper based preservative in preventing decay of wood inhabiting basidiomycetes.	Arch Chemical Inc.
1693	Ferguson	Tru-Tec	Radiotracer Production	Production of radioisotopes for use as industrial tracers.	Tru-Tec
1694	Craig	Oregon State University	HPLC Repair	Repair of HPLC units for use in detection of TNT in biota.	OSU Veterinary Medicine
1695	Teaching and Tours	Transitional Learning	Reactor Tour	Reactor Tour in D300 only	USDOE Reactor Sharing
1696	Sayer	Marquess & Associates Inc.	Instrument Calibration	Instrument calibration	Marquess & Associates Inc.
1697	Teaching and Tours	Crescent Valley High School	Crescent Valley High School AP Physics Class	This project supports the advanced placement physics class at Cresent Valley High School. It will utilize the reactor in ongoing research projects sponsored by Radiation Center staff.	USDOE Reactor Sharing
1698	Vulfson	Evanite Fiber Corporation	NAA of Fiberboard	NAA of fiberboard manufactured by Evanite Fiber Corperation to determine total chlorine content.	OSU Radiation Center

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress
at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1699	Teaching and Tours	Philomath High School	Reactor Tour	Tour of NAA and gas chromatograph capabilities in the Radiation Center	USDOE Reactor Sharing
1700	Frantz	Reed College	Instrument calibration	Instrument calibration	Reed College
1701	Minc	University of Michigan	NAA of Au labeled Antibodies	Radiolabeling with Au of antibodies in mice	USDOE Reactor Sharing
1702	Reese	Oregon State University	Neutron Spectrual Analysis	Determination of the neutron flux and spectrum in various OSTR irradiation facilities.	USDOE Reactor Sharing
1704	Rodriguez	Falls City High School	Irradiation of Bean Seeds	Irradiation of bean seeds @ 5, 10, 20, 40, 60 and 80 kRad	
1705	Hemming	Columbia University	Geochronology by Ar/Ar Methods		USDOE Reactor Sharing
1706	Wongsawaeng	University of California at Berkeley	Liquid Metal Bonding Tracer	Irradiated liquid metal is poured in the pellet-cladding gap in a mock nuclear fuel rod. Gold is used as a tracer to study the liquid metal bond integrity.	University of California at Berkeley
1707	Turrin	Rutgers	Ar/Ar Chronology Analysis	Statigraphy and Chronology of the Plio-Pleistocene Ngoronogoro volcanic highland	USDOE Reactor Sharing
1708	Turrin	Rutgers	Ar/Ar Chronology Analysis	Preliminary analysis on refining the age of the Monon Lake and Laschamp geomagnetic polarity events.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1709	Paulenova	Oregon State University	Complexation Constant Determination of Organometallic Tropolone Complexes	This experiment is designed to determine stability constants between metals and hinokitiol. Hinokitiol is a member of the tropolone family and an abundant component of essential oil in Librocedrus Decurrens. Radiotracer methodology will be applied in the experiment.	USDOE Reactor Sharing
1710	Frost	University of Wyoming	Determination of Geochemical Provenance of Muru Conglomerates, New Zealand	Major, minor, and trace element of clast in Muru conglomerates may reveal the lithological porvenance of this important tectonic terrane at an extinct subduction zone.	USDOE Reactor Sharing
1712	Bergman	Theragenics Corporation	Brachytheropy Source Activation	Activation of various source material for possible use in brachytherapy	Theragenics Corporation
1713	Gelhar	Oregon State University	Study of Ionizing Radiation on Pinto Bean Growth	Seed irradiation to study the effects of ionizing radiation on the growth of pinto beans.	OSU Radiation Center
1715	Teach	Providence St. Vincent Hospital	Stent Project	Irradiate elastin coated cardio stent devices to reduce thrombic reaction.	Providence NW Hospital
1716	Garcia	M. K. Gems and Minerals	Mineral irradiations to determine color characteristics	Mineral irradiations to determine color characteristics.	M. K. Gems & Minerals
1717	Webb	Syracuse University	Ar/Ar Dating	Ar/Ar Dating	Syracuse University
1718	Armstrong	California State University at Fullerton	Fission Track Dating	Fission track age dating of apatite grains from Santa Ana Mountains, California	Department of Geological Sciences

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.4

Summary of the Types of Radiological Instrumentation Calibrated
to Support the OSU TRIGA Reactor and the Radiation Center

Type of Instrument	Number of Calibrations
Alpha Detectors	2
GM Detectors	32
Ion Chambers	13
Micro-R Meters	2
Personal Dosimeters	53
TOTAL	102

Table VI.C.5

Summary of Radiological Instrumentation Calibrated
to Support Other OSU Departments and Other Agencies

Department/Agency	Number of Calibrations
OSU Departments	
Animal Science	2
Biochemistry/Biophysics	5
Botany and Plant Pathology	7
Center for Gene Research	1
Civil, Construction and Environmental Engineering	2
Crop Science	3
E.M.T.	4
Environmental Engineering	1
Fisheries and Wildlife	1
Food Sciences	2
Forest Engineering	1
Forest Science	1
Horticulture	2
Linus Pauling Institute	3
Mechanical Engineering	1
Microbiology	7
Nutrition and Food Management	2
Oceanic and Atmospheric Sciences (COAS)	3
Pharmacy	5
Physics	4
Radiation Safety Office	21
R/V Wecoma	1
Veterinary Medicine	7
Zoology	2
OSU Departments Total	88
Non-OSU Agencies	
ESCO Corporation	10
DOE Albany Research Center	1
Federal Aviation Administration	3
Good Samaritan Hospital	4
Lebanon Community Hospital	1
Marquess and Ass. Inc.	1
Northwest Const. Testing	1
Occ. Health Lab.	1
Oregon Office of Energy	45
Oregon Department of Transportation	6
Oregon Health Sciences University	23
Oregon Public Utilities Commission	5
Oregon State Health Division	65
Reed Reactor Facility	1
USDA Agricultural Research Service	1
U.S. Environmental Protection Agency	5
Valley Landfills, Inc.	2
Veterinary Diagnostic Imaging Cytopathology	2
Non-OSU Agencies Total	177

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
7/2/2003	25	Heal College, Physics Dept.
7/10/2003	25	Adventures in Learning
7/10/2003	25	Adventures in Learning
7/11/2003	20	Forensic Group
7/11/2003	20	Forensic Group
7/15/2003	3	Legal Advocacy Interns
7/17/2003	25	Adventures in Learning
7/17/2003	25	Adventures in Learning
8/1/2003	1	Prospective Under Graduate Student - Audrey Oberdick
8/5/2003	2	NASA -Explorer School teachers
8/7/2003	2	Belinda King, Dept. Head Mech. Engr.
8/20/2003	2	Karen Hamilton
8/22/2003	9	Jose Reyes family
8/25/2003	25	Ch 123
8/25/2003	25	Ch 123
8/26/2003	25	Ch 123
8/26/2003	25	Ch 123
8/27/2003	25	Ch 123
9/13/2003	7	National Academy of Engineering
9/26/2003	1	Prospective Post Bac Student - Lloyd McKinney
9/26/2003	1	Prospective Graduate - Heather Rankin
9/26/2003	7	INEL Class
10/17/2003	30	Inavale School

Table VI.F.1 (continued)

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
10/18/2003	32	Dad's Weekend
10/21/2003	18	Odessey (Erin Bosnjak)
10/23/2003	20	Pre-Engineering Group
10/27/2003	23	Odyssey Class - Ursula's
10/28/2003	20	GS106
10/28/2003	20	GS106
10/29/2003	12	Odessy (Beth Crawford)
10/30/2003	12	Lost River High School
10/30/2003	12	Wilsonville High School
10/30/2003	11	Leeper/Savannah Group
11/4/2003	20	GS 106
11/4/2003	20	GS106
11/8/2003	41	Beaver Open House
11/10/2003	18	Odessey (Adrian Irwin/Jessica Todd)
11/11/2003	23	Odessey (Valeria White/Matthew Lewis)
11/12/2003	24	Odessey (Jake)
11/13/2003	25	Odyssey Class - J. Todd's
11/25/2003	11	Transitional Learning
12/5/2003	21	Advanced Physics
12/9/2003	3	Fall City High School
12/10/2003	20	Senior Physics
12/11/2003	20	Senior Physics
12/16/2003	31	Philomath High School

Table VI.F.1 (continued)

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
1/8/2004	13	Chem 462
1/14/2004	16	Falls City/Dallas High School
1/16/2004	41	Reactor Operators
1/20/2004	1	Seminar Speaker - Herman Grunder, ARL
1/21/2004	18	Senior Physics
1/22/2004	17	Senior Physics
2/16/2004	1	Prospective Graduate Student - Brent Matteson
2/17/2004	25	Chem 222
2/17/2004	25	Chem 222
2/17/2004	25	Chem 222
2/17/2004	20	Chem 222
2/18/2004	20	Chem 222
2/18/2004	25	Chem 222
2/18/2004	25	Chem 222
2/19/2004	25	Chem 222
2/19/2004	25	Chem 222
2/19/2004	25	Chem 222
2/19/2004	25	Chem 222
2/24/2004	25	Chem 222
2/24/2004	25	Chem 222
2/24/2004	25	Chem 222
2/24/2004	25	Chem 222
2/25/2004	25	Chem 222

Table VI.F.1 (continued)

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
2/25/2004	25	Chem 205
2/25/2004	25	Chem 222
2/26/2004	5	Karmen Fod
2/26/2004	25	Chem 222
2/26/2004	25	Chem 222
2/26/2004	25	Chem 205
2/26/2004	25	Chem 222
3/1/2004	20	Chem 205
3/1/2004	20	Chem 222
3/2/2004	25	Chem 222
3/2/2004	25	Chem 205
3/2/2004	25	Chem 205
3/3/2004	25	Chem 205
3/3/2004	25	Chem 205
3/4/2004	25	Chem 222
3/4/2004	25	Chem 205
3/5/2004	20	SMILE students
3/5/2004	20	SMILE students
3/8/2004	25	Chem 205
3/9/2004	25	Chem 205
3/9/2004	25	CH 225 H
3/9/2004	28	Chemistry Class - 2nd year
3/10/2004	25	Chem 205

Table VI.F.1 (continued)

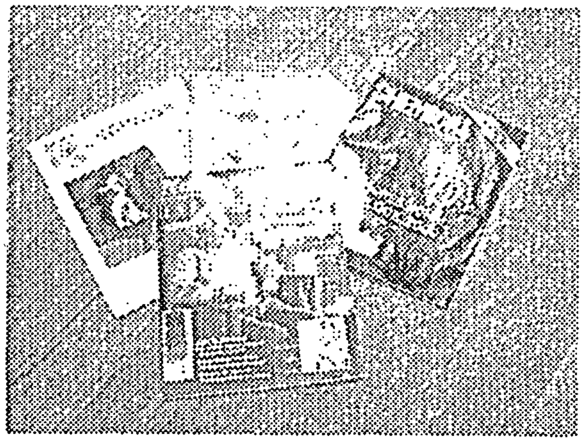
Summary of Visitors to the Radiation Center

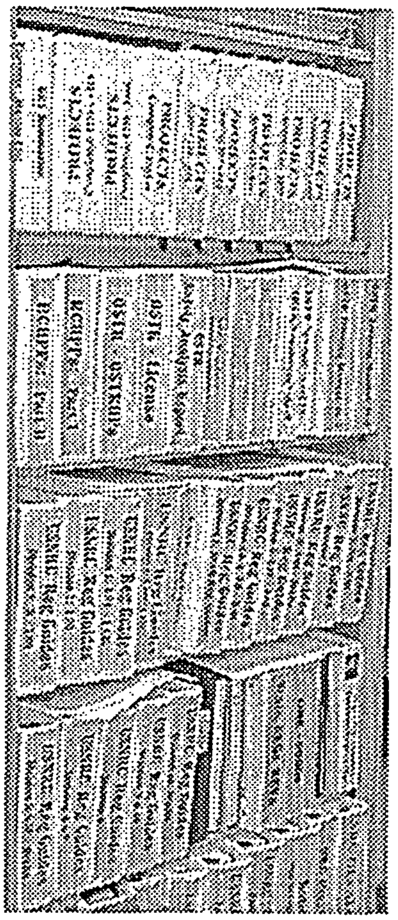
Date	No. of Visitors	Name of Group
3/11/2004	25	Chem 205
3/11/2004	25	Chem 225 H
3/23/2004	10	Tiger Scouts
3/26/2004	9	Family - Peter Sprunger
4/2/2004	20	SMILE students
4/2/2004	20	SMILE students
4/22/2004	2	OSU Foundation - Kathy Park & Sharon Magnuson
5/1/2004	23	Mom's Weekend
5/7/2004	1	Prospective UG - Jason White
5/11/2004	1	Seminar Speaker - Anil Prinja, Univ. New Mexico
5/17/2004	3	Alumni - Y.L. Wang & family
5/21/2004	10	Society of American Military Engineers
5/28/2004	2	Alumni - Carl Hoth & Julie Lanterman
6/2/2004	12	Geosciences 622
6/8/2004	2	Changer Lab personnel
6/15/2004	5	Hamilton Family -
6/22/2004	20	Adventures in Learning
6/28/2004	18	Forensic Group
6/29/2004	20	Adventures in Learning

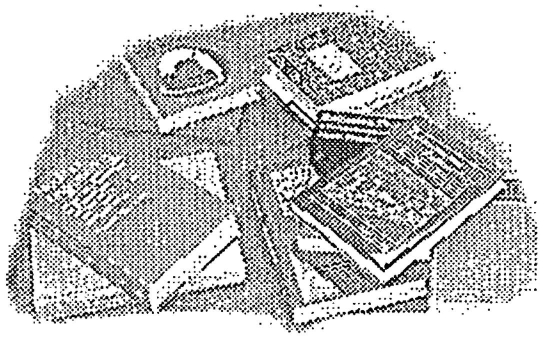
Total Tours: 111 **Total Visitors: 2075**

Part VII

Words







Part VII

WORDS

A. Documents Published or Accepted

Acton, G. 2004. 40Ar-39Ar ages for basalts drilled on ODP Leg 200. Proc. ODP, Sci Results, 200 (Texas A&M).

Ambrose, S.H., L.J. Hlusko, D Kyule and A.L. Deino. 2003. Lemudon'o: a new 6 Ma paleontological site near Norak, Kenya Rift Valley. Journal of Human Evolution. 44(6):737-742.

Audin, L., X. Quidelleur, E. Coulié, V. Courtillot, S. Gilder, I. Manighetti, P.-Y. Gillot, P. Tapponnier and K. Tesfaye. 2004. Paleomagnetism and K-Ar and 40Ar/39Ar ages in the Ali Sabieh area (Republic of Djibouti and Ethiopia): constraints on the mechanisms of Aden ridge propagation into southeastern Afar during the last 20 Myr. Geophys. J. Int. 148:327-345.

Barbieri, C., B. Carrapa, A. DiGiulio, J.R. Wijbrans and G. Murrell. 2003. Provenance of Oligocene syn-orogenic sediments of the Ligurian Alps (NW Italy): Inferences on the belt age and its cooling history. International Journal of Earth Sciences. 92:758-778.

Blumenschine, R.J., C.R. Peters, F.T. Masao, R.J. Clarke, A.L. Deino, R.L. Hay, C.C. Swisher, I.G. Stanistreet, G.M. Ashley, L.J. McHenry, N.E. Sikes, N.J. van der Merwe, J.C. Tacios, A.E. Cushing, D.M. Deocampo, J.K. Njau and J.I. Ebert. 2003. Late pliocene Homo and hominid land use from western Olduvai Gorge, Tanzania. Science 299(5610):1217-1221.

Blythe, A.E., M. d'Alessio and R. Bürgmann. 2004. Constraining the exhumation and burial history of the SAFOD pilot hole with fission track and (U-Th)/He thermochronometry. Geophysical Research Letters. Vol. 31.

Burbank, D.W., A.E. Blythe,J. Putkonen, B. Pratt-Sitaula, E. Gabet, M., Oskin, A. Barros and T. Ohja. 2003. Decoupling of erosion and precipitation in the Himalayas: Nature, v. 426:652-655.

Carrapa, B. and J.R. Wijbrans. 2003. Cretaceous $^{40}Ar/^{39}Ar$ detrital mica ages in Tertiary sediments, solving the debate on the Eo-Alpine evolution? *In*. Geochronology and Structural geology (Journal of the Virtual Explorer), M. Foster and J. Wijbrans, eds. V.13(60)

Carrapa, B. J.R. Wijbrans and G. Bertotti. 2003. Episodic exhumation in the Western Alps. Geology. 31(7):601-604

Carrapa, B., J.R. Wijbrans and G. Bertotti. 2004. Detecting differences in cooling/exhumation patterns within the Western Alpine arc through $^{40}Ar/^{39}Ar$ thermochronology on detrital minerals (Tertiary Piedmont Basin, NW Italy). *In* 'Detrial Thermochronology' GSA special volume, M. Bernett and C. Spiegel, eds.

Corrado, S., L. Aldega, P. DiLeo, C. Giampaolo, C. Invernizzi and M. Zattin. Accepted. Combined use of thermal indicators to study the tectono-sedimentary evolution of Southern Apennines (Italy). Terra Nova.

Cousens, B.L., D.A. Clague and W.D. Shar0p. 2003. Chronology, chemistry and origin of trachytes from Hualalai Volcano, Hawaii. Geochemistry, Geophysics, Geosystems. 4(9):1-27/

Duncan, R.A. and R.A. Keller. 2004. Radiometric ages for basement rocks from the Emperor Seamounts, ODP Leg 197. Geochem. Geoiphys. Geosys.paper 2004GC00704.

Ege, H., E. Sobel, V. Jocobshagen, E. Scheuber, and D. Mertmann. 2003. Exhumation history of the Central Andes of southern Bolivia by apatite fission track dating *in* R. Suárez-Soruco et. al., ed., Revusta Técnica de Yacimientos Petrolíferos Fiscales Bolivianos (YPFB), Cochabamba, Boliva, v. 21, p. 165-172.

Fellin, M.G. V. Picotti and M. Zattin. Accepted. Neogene to Quaternary multiple rifting and inversion in north-eastern Corsica: retreat and collision in the Western Mediterranean. Techtonics.

Fellin, M.G., M. Zattin, V. Picotti, P.W. Reiners and S. Nicolescu. Accepted. Relief evolution in northern Corsica (western Mediterranean) constraints on uplift and ereosion at the long-term and short-term time scales. Journal of Geophysical Research - Earth Surface.

Ferrandini, J., J. Gattaccece, M. Ferrandini, A.L. Deino and M.C. Janin. 2003. Chronostratigraphy and peleomagnetism of Oligo-Miocene deposits of Corsica (France): geodynamic implications for the liguro-provencal basin spreading. Bulletin de la Society Geologique de France. 174(4):357-371.

Glen, J.M.G., J.P. Valet, V. Soler, P.R. Renne and A. Elmaleh. 2003. Neogene geomagnetic polarity transition record from lavas of the Canary Islands, Spain: Episodic volcanisms and/or metastable transitional fields? Geophysical Journal International. 154(2):426-440.

Horn, S.P., R.L. Sanford, D. Dilcher, T.A. Lott, P.R. Renne, M.C. Wiemann, D. Cozadd and O. Vargas. 2003. Pleistocene plant fossils in and near LaSelva Biological Station, Costa Rica. Biotropica. 35(3):434-441.

Hughes, S.S., S.E. Lewis, M.J. Bartholomew, A.K. Sinha, and N. Herz. 2004. Geology and geochemistry of Fe-Ti-rich granitic and charnockitic rocks in the central Lovingston massif of the Grenvillian Blue Ridge terrane, U.S.A. *In* R.P. Tollo, L. Corriveau, J. McLelland, and M.J. Bartholomew, eds., Proterozoic Tectonic Evolution of the Grenville Orogen in North American: Boulder, Colorado, Geological Society of American Memoir no. 197, p. 549-569.

Hughes, S.S., P.H. Wetmore and J.L. Casper. 2002. Evolution of Quaternary tholeiitic basalt eruptive centers on the eastern Snake River Plain, Idaho. *In* B. Bonnichsen, C. White, and M. McCurry, eds., Tectonic and magmatic evolution of the Snake River Plain volcanic province: Idaho Geological Survey Bulletin 30, p. 363-385.

Hughes, S.S. and M. McCurry. 2002. Geochemical evidence for time-space evolution of Snake River Plain rhyolites. *In* B. Bonnichsen, C. White, and M. McCurry, eds., Tectonic and magmatic evolution of the Snake River Plain volcanic province: Idaho Geological Survey Bulletin 30, p. 161-176.

Jordan, B.T., A.L. Grunder, R.A. Duncan, and A.L. Deino. 2004. Geochronology of Oregon High Lava Plains volcanisms: Mirror image of the Yellowstone Hotspot? Journal Geophys. Research, paper 2003JB002776.

Koppers, A.A.P., R.A. Duncan and B. Steinber. 2004. Implications of a non-linear 40Ar/39Ar age progression along the Louisville seamount trail for models of fixed and moving hotspots. Geochem. Geophys. Geosys., paper 2003GC000671.

Koppers, A.A.P., H. Staudigel, M.S. Pringle and J.R. Wijbrans. 2003. Short-lived and discontinuous intra-plate volcanisms in the South Pacific: hotspots or extensional volcanism? Geochemistry, Geophysics, Geosystems. 61.

Kuiper, K.F., F.J. Hilgen, S. Steenbrink and J.R. Wijbrans. 2004. $^{40}Ar/^{39}Ar$ ages of tephras intercalated in astronomical tuned Neogene sedimentary sequences in the Eastern Mediterranean. Earth and Planetary Science Letters. 222:583-597.

Lips, A.L.W., R.J. Herrington, G. Stein, D. Kozelj, K. Popov and J.R. Wijbrans. 2004. Refined timing of porphyry copper formation in the Serbian and Bulgarian portions of the Cretaceous Carpatho-Balkan belt. Economic Geology. 99:601-609.

Liu, J.Z., R.L. Hay, A.L. Deino and T.K. Kyser. 2003. Age and origin of authigenic K-feldspare in uppermost Precambrian rocks in the North American Midcontinent. Geological Society of America Bulletin. 115(4):422-433.

Marzoli, A., H. Bertrand, K.B. Night, S. Cirilli, R. Martini, V. Vérati, N. Youbi, S. Nomade, K. Allenback, R. Neuwerth, C. Rapaille, N. Buratti, L. Zaninetti, G. Bellieni and P.R. Renne. 2004 in press. Synchrony of the Central Atlantic magmatic province and the Triassic-Jurassic boundary. Geology.

Mertz, D.F., P.R. Renne, and Z. Fekiacova. 2004 in press. 40Ar/39Ar dating on volcanic rocks from Enspel fossil desposit (Westerwald, Germany): implications for the calibration of mammal paleogene standard levels from the European upper oligocene. Newsletters on Stratigraphy.

Mertz, D.F., W.D. Sharp and K.M. Haase. 2004 in press. Volcanism on the Eggvin Bank (Central Norwegian-Greenland Sea, Latitude 71 degrees N): age, source, and relationship to the Iceland and putative Jan Mayen plumes. Journal of Geodynamics.

Nomade, S., P.R. Renne, and R.K.W. Merkle. 2004. 40Ar/39Ar age constraints on ore depostion and cooling of the Bushveld Complex, South Africa. Journal of the Geological Society of London. 161:411-420.

Nomade, S. P.R. Renne, X. Mo, Z. Zhao and S. Zhou. 2004. Miocene Potassic and Ultrapotassic Volcanism in the Lhasa Block: Spatial Trends and Geodynamic Implications. Earth and Planetary Science Letters. 221:227-243.

O'Connor, J.M., P. Stoffers and J.R. Wijbrans. 2004. The Foundation Chain: Inferring hotspot plate interaction from a weak seamount trail. *In* R. Hekanian, P. Stoffers and J-L Cheminee, eds. Oceanic Hotspots, Intraplate submarine magmatism and tectonism. Pp. 480. Springer Publishers.

Quade, J., N. Levin, S. Semaw, D. Stout, P.R. Renne, M. rogers, S. Simpson. 2004 in press. Paleoenvironments of the Earliest Stone Toolmakers, Gona, Ethiopia. Geological Society of American Bullein.

Ravenhurst, C.E., M.K. Roden-Tice, and D.S. Miller. 2003. Thermal annealing of fission tracks in fluorapatite, chlorapatite, manganoanapatite and Durango apatite: Experimental results. Canadian Journal of Earth Sciences. 40:995-1007

Renne, P.R., K.B. Knight, S. Nomade, K.-N. Leung and T.-P. Lou. 2004 in press. Application of a deuteron-deuteron (D-D) neutron generator to 40Ar/39Ar geochronology. Applied Radiation and Isotopes.

Rettalack, G.J., W.N. Orr, D.R. Prothero, R.A. Duncan, P.R. Kester and C.P. Ambers. 2004. Eocene-Oligocene extinction and paleoclimate change near Eugene, Oregon. Geol. Soc. Amer. Bull 116:817-839

Schmitz, M.D. S.A. Bowring, K.R. Ludwig and P.R. Renne. 2003. Comment on "Precise K-Ar, 40Ar-39Ar, Rb-Sr and U-Pb mineral ages from the 27.5 Ma Fish Canyon Tuff rerference stands". Chemical Geology. 199:277-280.

Schultz, P.H., M. Zárate, B. Hames, C. Koeberl, T. Bunch, D. Storzer, P.R. Renne and J. Wittke. 2004. The Quaternary impact record from the Pampas, Argentina. Earth and Planetary Sciences Letters. 219:221-238.

Semaw, S. M.J. Rogers, J. Quade, P.R. Renne, R.F., Butler, M. Dominguez-Rodrigo, D. Stout, W.S. Hart, T. Pickering and S.W. Simpson. 2003. 2.6-Million-year-old stone tools and associated bones from OGS-6 and OGS-7, Gona, Afar, Ethiopia. Journal of Human Evolution. 45:169-177.

Shervais, J.W., B.L. Murchey, D.L. Kimbrough, P.R. Renne and B. Hanan. 2004 in press. Radioisotopic and Biostratigraphic Age Relations in the Coast Range Ophiolite, Northern California: Implications for the Tectonic Evolution of the Western Cordillera. Geological Soceity of American Bulletin.

Sobel, E.R and M.R. Strecker. 2003. Uplift, exhumation and precipitation: Tectonic and climatic control of Late Cenozoic landscape evolution in the northern Sierras Pampeanas, Argentina: Basin Research, v. 15., doi: 10.1046/j.1365-2117.2003.00214.x.

Spikings, R.A., D.A. Foster, B.P. Kohn and G.S. Lister. 2001. Post-orogenic thermal history of the Mesoproterozoic Eastern Successions, Mount Isa Inlier, Australia. Precambrian Research 109:103-144

Spikings, R.A., D.A. Foster, B.P. Kohn, and P.B. O'Sullivan. 2001. Tge Late Neoproterozoic to Recent thermal history fo the Precambrian Georgetown Inlier, northeast Australia.. Australian Journal of Earth Sciences 48:9-24.

Spikings, R.A. D.A. Foster, B.. Kohn, and G.S. Lister. 2002. Post-orogenic (<1500 Ma) thermal and tectonic reactviation history of some Palaeo-Mesoproterozoic provinces in NE Australia. Tectonophysics 349:327-365.

Stewart, R.J. and M.T. Brandon. 2004. Detrital zircon fission-track ages for the "Hoh Formation": Implications for the late Cenozoic evolution of the Cascadia subduction wedge. Geological Society of America bulletin, v. 116, no. ½, p. 60-75.

Thiede, R.C., B. Bookhagen, J.R. Arrowsmith, E.R. Sobel, and M.R. Strecker. 2004. Climate control on rapid exhumation along the Southern Himalayan Front: Earth and Planetary Science Letters. V. 222, p. 791-806.

Trauth, M.H., A.L. Deino, G.N. Andreas, G.N. Berner and M.R. Strecker. 2003. East African climate change and orbital forcing during the last 175 kyr BP. Earth and Planetary Science Letters. 206:297-313.

Von Eynatten, J. and J.R. Wijbrans. 2003. Precise tracing of exhumation and provenance using $^{40}Ar/^{39}Ar$ geochronology of detrial white mica: the example of the Central Als. *In* R. McCann and G. Saintot, eds. Tracing Tectonic deformation using the sedimentary record. Geological Society Special Publication. 204:289-305

West, D.P. Jr., M.K. Roden-Tice. 2003. Late cretaceous reactivation of the Norumbega fault zone, Maine: Evidence from apatite fission track ages. Geology. 31:649-652

WoldeGabriel, G., P.R. Renne, W.K. Hart, S. Ambrose, B. Asfaw and T.D. White. 2004. Geoscience Methods Lead to Paleo-anthrolopoligcal Discoveries in Afar Rift, Ethiopia. Eos 85(29):273-280.

Wolfenden, E., C. Ebinger, G. Yirgu, P.R. Renne and S.P. Kelley. 2004 in press. Evolution of a volcanic rifted margin: southern Red Sea, Ethiopia. Geological Society of American Bulletin.

Wright, K.E., M. McCurry and S.S. Hughest. 2002. Petrology and geochemistry of the Neogene Tuff of McMullen Creek, central Snake River Plain. *In* B. Bonnichsen, C. White, and M. McCurry, eds., Tectonic and magmatic evolution of the Snake River Plain volcanic province: Idaho Geological Survey Bulletin 30, p. 177-194.

Zattin, M. and G.G. Zuffa. 2004. Uneaveling source rocks of episutural and foredeep Late Eocene-Miocene arenities of norterh Apennines and southern Alps. Bollettino Società Geologica Italiana. 123:67-76.

Zhu, R., K.A. Hoffman, S. Nomade, P.R. Renne, R. Shi, Y. Pan and G. Shi. 2004. Geomagnetic paleointensity and direct age determination of the ISEA (M-Or?) Chron. Earth and Planetary Science Letters. 271:285-295.

B. Documents Submitted for Publication

Fellen, M.G. P.W. Reiners, M.T. Brandon, M.L. Balestrieri, G. Molli and M. Zattin. Exhumation of the Northern Apennines core: low-temperature thermochronology of the Alpi Apuane. Submitted to Tectonics.

Fleischer, R.L., S. Change, J. Farrell, R.C. Herrman, J. MacDonald, M. Zalesky and R.H. Doremus. 2004. Etched tracks and serendipitous dosimetry. Submitted to Radiation Protection Dosimetry.

Haschke, M. E.R. Sobel, lP. Blisniuk, M.R. Strecker, P. Warkus. In Review. Balancing reheating, uplift and exhumation due to subduction of an active spreading center, Patagonian Andes. Geological Society of America Bulletin.

Knight, K.B., S. Nomade, P.R. Renne. A. Marzoli, H. Bertrand and N. Youbi. 2004. The Central Atlantic Magmatic Province at the Triassic-Jurassic boundary: Paleomagnetic and 40Ar/39Ar evidence from Morocco for brief, episodic volcanism. Earth and Planetary Science Letters. Resubmitted.

Leloup, P.H., N. Arnaud, E.R. Sobel, and R. Lacassin. In Revision. Timing and mode of exhumation of the highest alpine range, the Mt. Blanc massif. Submitted to Tectonics.

Thiede, R.C., J.R. Arrowsmith, B. Bookhagen, M. McWilliams, E.R. Sobel, M.R. Strecker. In Review. 10 Ma of E-W extension of the Tethyan Himalaya, Leo-Pargil Dome, NW-India. Submitted GSA Bulletin

Stewart, R.J., B. Hallet, P.K. Zeitler, C.M. Allen and D. Trippett. 2004. Extremely rapid erosion localized in the easternmost Himalaya. Submitted to Nature.

C. Documents in Preparation

Carrapa, B. D. Adelmann, G.E. Hilley, M.R. Strecker, and E.R. Sobel. In prep. Oligocene uplift, establishment of internal drainage and development of plateau morphology in the southern Central Andes. To be submitted to Tectonics.

Coutand, I., B. Carrapa, E.R. Sobel, and M.R. Strecker. In prep. Cenozoic uplift and lateral growth of the Altiplano-Puna plateau (central Andes, NW Argentina): new insights from detrital apatite fission-track thermochronology and sandstone petrography. To be submitted to Basin Research or GSA Bulletin.

Sobel, E.R., M. Oskin, D. Burbank and A. Mikolaichuk. In prep. Exhumation of basement-cored uplifts: Example of the Kyrgyz range quantified with apatite fission-track thermochronology. To be submitted to GSA Bulletin.

Zattin, M. A. Cuman, R. Fantoni, S. Martin, P. Scotti and C. Stefani. In prep. Cooling during burial: the thermal record in the sediments of the Colomite region (Central Als, Italy). Transalp Special Volume.

D. Thesis and Student Project Reports

D'Amelio, F. Pliocene-Pleistocene Volcanisms in Sardinia. PhD. University of Naples, Italy.

Bendezu, R. Carbonate-hosted Zn-Pb±(Ag,Cu,Bi)-alunite-kaolinite mineralization as product of a high sulfidation epithermal system. The Colquijirca District, central Peru. PhD. University of Geneva, Switzerland.

Brady, S.M. Volcanology and petrology of Table Legs Butte and Quaking Aspen Butte, Eastern Snake River Plain, Idaho. MS. Idaho State University, Pocatello, Idaho.

Buchwaldt, R The Age and Composition of Plutonic Activity, Madagascar. PhD. Washington University, St. Louis, Missouri.

Carrapa, B. Tectonic Evolution of an Active Orogen As Reflected by its Sedimentary Record: an Integrated Study of the Tertiary Piedmont Basin (Internal Western Als, Italy). PhD. Department of Isotope Geochemistry, Vrije Universiteit, Amsterdam, Netherlands.

Casperson, R. The neutron capture cross section of Gd-148. BS. Department of Physics, Oregon State University, Corvallis, Oregon

Chadwick, C.G. Petrogenesis and correlation of the high-K_2O and high-MgO subsurface basalts at the INEEL, Idaho. MS. Idaho State University, Pocatello, Idaho.

Ege, H. 2004. Tectono-sedimentary evolution of the southern Altiplano: Basin evolution, thermochronology and structural geology. PhD. Freie Universitaet, Berlin, Germany.

Deeken, A. Age of initiation and growth pattern of the Puna Plateau, NW-Argentina. PhD. Freie Universitaet, Berlin, Germany.

Flude, S. Rhyolite Volcanism in Iceland: Timing and Timescales of eruption. PhD. Department of Earth Sciences, University of Manchester, Manchester, United Kingdom.

Hager, W. Using angular correlations to determine decay behavior in nuclei through the analysis of coincidence sum peaks. Honors BS. Department of Physics, Oregon State University, Corvallis, Oregon.

Harijoko, A. Gold Minearlization in Cibaliung, Western Java, Indonesia. MS, Kyoto University, Kyoto, Japan.

Hoppe, D. Timing of exhumation of the northern Santa Ana Mountains. MS. Department of Geological Sciences, California State University at Fullerton, California.

Irwin, C. Exhumation and basin inversion in the San Jose Hills and Puente Hills, eastern Los Angeles basin. MS. Department of Geological Sciences, California State University at Fullerton, California.

Kamada, M. Geochemistry and structural aspects of the Etive Dyke Swarn, western Scotland. MSc. University of Geneva, Switzerland.

Klemetti, E. Evolution of Arc Volcanoes, Andes Mountains, Chile. PhD. Oregon State University, Corvallis, Oregon.

Kuiper, K.F. Direct Intercalibration of Radio-Isotopic and Astronimcal Time in the Mediterranean Neogene. PhD. Department of Isotope Geochemistry, Vrije Universiteit, Amsterdam, Netherlands.

Longo, A. The Timing of Copper Mineralization in the Peru Andes. PhD. Oregon State University, Corvallis, Oregon.

Luzieux, L. Syn- and post-accretinary history of the Ecuadorian forearc. PhD. University of Geneva, Switzerland.

Malusa, M.G. Post-metamorphic evolution of the Western Alsp: kenematics constraints from a multidisciplinary approach. PhD. University of Torino, Italy.

Mazurek, J. Geochemistry of authigenic minerals in borehole 1823, Idaho National Engineering and Environmental Laboratory, SE Idaho. MS. Idaho State University, Pocatello, Idaho.

McCutheon, M. Geology of the Mt. Solo region, Washington. MS. Oregon State University, Corvallis, Oregon.

Mora, A. Late cenozoic uplift and deformation of the eastern flank of the Columbian Eastern Cordillera. PhD. Universitaet Potsdam, Golm, Germany.

Morrison, K. Burial depths of the Cretaceous – Eocene section of the northern Santa Ana Mountains. BS. Department of Geological Sciences, California State University at Fullerton, California.

Parra, M. Neogene and quaternary synorogenic sedimentation and exhumation history fo the eastern foreland fold-and-thrust belt of the Columbian Andes. PhD. Universitaet Potsdam, Golm, Germany.

Perry, S. Evaluation of source region exhumation using detrital zircon fission-track dating – eastern Los Angeles basin. MS. Department of Geological Sciences, California State University at Fullerton, California.

Pickett, K.E. Physical volcanaology, petrography, and geochemistry of basalts in the biomodal blackfoot volcanic field, southeastern Idaho. MS. Idaho State University, Pocatello, Idaho.

Rowe, M. Geology of the Central Oregon Cascades. PhD. Oregon State University, Corvallis, Oregon.

Sanematsu, K. Timing of Mineral Deposits at the Hishikari Gold Prospect, Japan. PhD. Kyoto University, Kyoto, Japan.

Scarberry, K.C. Volcanology, geochemistry and stratigraphy of the F basalt flow group, Eastern Snake River Plain, Idaho. MS, Idaho State University, Pocatello, Idaho.

Schmidt, M. The Volcanic Development of North Sister, Oregon Cascades. PhD. Oregon State University, Corvallis, Oregon.

Selles, D. Geology, volcanic stratigraphy, geochronology, and petrology of the Cordón Villalobos volcanic complex (36.3°S, Southern Volcanic Zone, Chile). PhD. University of Geneva, Switzerland.

Thiede, R. Climatic-tectonic interaction in the development of the Himalaya orogen: The example of the Sutlej valley, NW Himalaya, India. Universitaet Potsdam, Golm, Germany.

Vallejo, C. Tectonic and thermal history of the Cordiller Occidental, Ecuador. PhD. University of Geneva, Switzerland.

Villagomez, D. Tectonic and thermal history of the allochthonous Colombian Andes. PhD. University of Geneva, Switzerland.

E. Presentations

Bendezú, R., R. Baumgartner, R. Fontboté, L. Page, Z. Pecskay and R. Spikings. 2004. ~2 My of pulsed high sulfidation hydrothermal activity in the Cerro de Pasco-Colquijirca "super district", Peru. Combining furnace and infra-red laser 40Ar/39Ar, and K/AR analysis on alunite. Society of Economic Geologists, Perth, Australia.

Blythe. A.E., M.A. d'Alessio, R. Bürgmann and K.A. Farley. 2003. Low temperature thermochronology from the SAFOD pilot hole: constraining the thermal history with apatite fission-track and (U-Th)/He analyses [abs.]: EOS Transactions, A.G.U, v. 84, no. 47: F1005.

Blythe, A.E., K. Schmidt, J. Putkonen and D.W. Burbank. 2004. A detailed cooling history of the central Nepalese Himalaya over the last 2.5 Mya, from apatite fission track and (U-Th)/He analyses. 10th International Conference on Fission Track Dating and Thermochronology, Amsterdam, Netherlands.

Brady, S.M., S.S. Hughest, S.E.H. Sakimoto and T.K.P. Gregg. 2004. Field and geochemical study of Table Legs Butte and quaking Aspen Butte, Eastern Snake River Plain, Idaho: An analog to the morphology of small shield volcanoes on Mars. Lunar and Planetary Science XXXV, no. 2147.

Brady, S.M., S.S. Hughes, S.E.H. Sakimoto and T.K.P. Gregg. 2004. Textural study of Table Legs Butte and Quaking Aspen Butte, eastern Snake River Plain, Idaho: An analog to small shield volcanoes on Mars. Geological Society of America Abstracts with Programs Vol. 36, No. 4, Rocky Mountain Section Meeting, Boise, Idaho.

Carrapa, B., J.R. Wijbrans and G. Bertotti. 2003. Cretaceous 40Ar/39Ar detrital mica ages in tertiary sediments, solving the debate on the Eo-Alpine evolution? Geophysical Research Abstract. Vol 5. 02259. European Geophysical Society.

Carrapa, B., D. Adelmann, E.R. Sobel, and M.R. Strecker. 2004. Oligocene uplift in the southern central Andes: Implications for early plateau development and aridification. 10th International Fission Track 2004 Conference, Amsterdam, Netherlands.

Ceriani, A., A. Digiulio, R. Fantoni, A. Ortenzi, P. Scotti and M. Zattin. 2004. Cooling related to heat-flow decrease in post-rift sequences. 32nd International Geological Congress, Firenze, Italy.

Coutand, I.C., B. Carrapa, M.R. Strecker, and E.R. Sobel. 2004. Cenozoic uplift and lateral growth of the Altiplano-Puna plateau (central Andes, NW Argentina): New insights from detrial apatite fission-track thermochronology and sandstone petrography. 10th International Fission Track 2004 Conference, Amsterdam, Netherlands.

Deeken, A.D., E.R. Sobel, M.R. Haschke, M.R. Strecker and U. Riller. 2004. Age of Initiation and Growth Pattern of the Puna Plateau, NW-Argentina, Constrained by AFT Thermochronology. 10th International Fission Track 2004 Conference, Amsterdam, Netherlands.

DeBeni, E., J. Wijbrans, S. Branca, M. Coltelli and G. Groppelli. 2003. Application of the 40Ar/39Ar technique to define the main evolutive phases of Mount Etna volcanic activity. FIST GEOITALIA 2003. Session volcanology. Firenze, Italy.

DeJong, K., M.J. Timmerman, R.A. Cliff, J.R. Wijbrans, J.S. Daly and V.V. Balagansky. 2003. Resetting of the Neoarchaean hornblendes from the Murmansk terrane (Kola Peninsula, Russia) revealed by combined 40Ar/39Ar and Rb-Sr analysis. EGS meeting EAE03-A-12335. Nice, France.

Duncan, R.A. 2004. Hotspots and Fixed Mantle Plumes: Results from ODP Leg 197, Emperor Seamounts. Woods Hole Oceanographic Institution, Geodytnamics Seminar. Woods Hole, Massachusetts.

Duncan, R.A. 2004. Moving Hotspots and the Record of Volcanism in the Hawaiian-Emperor Seamounts. Departmental Seminar, Portland State University, Portland Oregon.

Duncan, R.A. 2004. Are Hotspots Fixed? Evidence from the Emperor Seamounts, ODP Leg 197. Departmental Seminar, University of Wisconsin, Madison, Wisconsin.

Fellin, M.G., P.W. Reiners, M.T. Brandon, G. Molli, M.L. Balestrieri and M. Zattin. 2004. Exhumation of the Northern Apennines core: new thermochronological data from the Alpi Apuane. 32nd International Geological Congress, Firenze, Italy.

Fellin, M.G., M. Zattin, V. Picotti, P.W. Reiners and S. Nicolescu. 2004. U-Th/He and fission track dating in north-eastern Corsica (France): extensional versus erosional exhumation. 10th International Fission Track Conference, Amsterdam, Netherlands.

Fleischer, R.L., S. Change, J. Farrell, R.C. Herrman, J. MacDonald, M. Zalesky and R.H. Doremus. 2004. Etched Tracks and Serendipitous Dosimetry. 14th International Conference on Solid State Dosimetry. Yale University, New Haven, Connecticut.

Flude, S., R. Burgee, and D. McGarvie. 2004. Eruption ages and geochemical evolution of Kerlingarfjoll central volcanic complex, Iceland. Poster Presentation. Volcanic and Magmatic Studies Group Annual Meeting. Bath, United Kingdom.

Flude, S., D. McGarvie, and R. Burgess. 2002. Subglacial rhyolites from Kerlingarfjoll, Iceland: geochemical evolution and preliminary eruption ages. Volcanic and Magmatic Studies Group Annual Meeting (Part II). Edinburgh, United Kingdom.

Flude, S., D. McGarvie and R. Burgess. 2003. Subglacial rhyolites from Kerlingarfjoll, Iceland: geochemical evolution and preliminary eruption ages. Poster Presentation. NSF/NorFa Summer School, Tectonic-Magmatic Interaction. Geysir, Iceland.

Ford, M.T. and M. McCurry. 2003. Petrology of Quaternary rhyolite domes of the bimodal Blackfoot volcanic field - southeast Idaho. Geological Society of America Abstracts with Program. V35(5):631. Annual Meeting in Seattle, Washington.

Ford, M.T., M. McCurry, and M. Chadwick. 2004. Genesis of Quaternary Rhyolite Domes of the Eastern Snake River Plain and Blackfoot Volcanic Field, SE Idaho. Geological Society of America Abstracts with Programs Vol. 36, No. 4, Rocky Mountain Section Meeting, Boise, Idaho.

Hughes, S.S., S.E.H. Sakimoto, T.K.P. Gregg, D.J. Chadwick, S.M. Brady, M.A. Farley, A.A.J. Holmes, A.M. Semple and S.L. Weren. 2004. Topographic Evidence for Eruptive Style Changes and Magma Evolution of Small Plains-style Volcanoes on Earth and Mars. Lunar and Planetary Science XXXV, no. 2123. Houston, Texas.

Invernizzi, C. L. Aldega, G. Cello, S. Corrado, P. DiLeo, C. Giampaolo, C. Martino, S. Mazzoli, M. Zattin, and G.G. Zuff. 2004. Thermal constraints and modeling for the Neogene-Quaternary evolution of the Lucanian sector of the Southern Apennines (Italy). 32nd International Geological Congress, Firenze, Italy.

Kuiper, K.R., F>J. Hilgen, W. Krijgsman and J.R. Wijbrans. 2003. An astronomically dated standard in 40Ar/39Ar geochronology? Abstract. Fall AGU, San Francisco, California.

Malusa, M.G., P. Philippot, M. Zattin and S. Martin. 2004. Fluid inclusion analysis as a calibration tool for exhumation rate studies: interpretation of fission-track data from the Western Alps. 10th International Fission Track Conference, Amsterdam, Netherlands.

Mikolaichuk, A., E. Sobel, M. Gubrenko, and A. Lobanchenko. 2003. Structural Evolution of the Chu foreland basins (North Tien Sdhan). 18th Himalaya-Karakorum-Tibet Workshop, 2-4 April 2003, Monte Verita, Ascona, Switzerland, p. 80-81.

McCurry, and L.H. Morse. 2003. CH-1: Implications for Quaternary, eastern Snake River Plain-style intermediate-composition volcanism. Geological Society of America Abstracts with Program. v 35(6). Annual Meeting in Seattle, Washington.

O'Connor, J.M., P. Stoffers and J.R. Wijbrans. 2003. Lithospheric and Melt Anomaly Control of Foundation Chain Volcanism. Abstract. Fall AGU, San Francisco, California.

Page, L., T. Dunai, J. Wijbrans and P. Andriessen. 2003. Multi-method low temperature geochronology from the Bergell Pluton, Italian Alps: Utilizing K-feldspar 40Ar/39Ar multidiffusion domain modeling, conventional 40Ar/39Ar biotite dating, T-Th-He apatite, and fission dating. EGS meeting. EAE03-A-10434. Nice, France.

Page, L., R.A. Spikings, R. Bendezú and L. Fontboté. 2004. Step-wise infra-red (CO2) laster ablation 40AR/39Ar analysis of hydrothermal alunities: an example from Colquijirca district, central Peru. EGU Assembly, Nice, France.

Qiu, H.N., J.R. Wijbrans and X.H. Li. 2003. 40Ar/39Ar mineralization ages of the Dingchuan Copper Deposits, Yunnan, SW China. Abstract. Goldschmidt conference, Kurashiki, Japan.

Renzulli, A., A. Tibaldi, M. Menna, S. Flude and R. DeCaro. 2004. Quaternary single-extrusive silicic domes and crust tectonic relaxation in te Central Volcanic Zone of the Andes. Poster Presentation. International Geological Congress of Florence, Italy.

Roden-Tice, M.K., D.P. West, Jr., R.P. Wintsch, J. Winch, and J. Potter. 2004. Late Mesozoic exhumation of the Northern Appalachian orogen: Information from apatite fission track ages. Geological Society of American Abstracts with Programs 36(2). Presented at the Northeastern-Southeastern Section Meeting of the Geological Society of America, Tysons Corner, Washington, D.C.

Sobel, E.R. 2003. Tectonic and climatic control of landscape evolution in the northern Sierras Pampeanas, Argentina. AGU fall meeting, Eos. Trans. AGU, San Francisco, California.

Sobel, E.R. 2003. Uplift, exhumation, and precipitation: Tectonic and climatic control of landscape evlution in the northern Sierras Pampeanas, Argentina. Deutsche Mineralogische Gesellschaft Annual Meeting, Bochum, Germany.

Sobel, E.R., D. Seward, G. Ruiz, A. Kuonov, H. Ege, M. Wipf, and C. Krugh. 2004. Influence of Etching Conditions on Dpar Measurements: Implications for Thermal Modeling. 10th International Fission Track 2004 Conference, Amsterdam, Netherlands.

Sobel, E.R., M. Oskin, D. Burbank and A. Mikolaichuk. 2004. Exhumation of Basement-Cored Uplifts: Example of the Kyrgyz Range Quantified with Apatite Fission-Track Thermochronology. AGU Fall meeting, Eos, Trans. AGU, San Francisco, California.

Sobel, E.R. and M.R. Strecker. 2004. Tectonic and climatic control of landscape evolution in the northern Sierras Pampeanas, Argentina. 19th Sedimentological Conference 2004, Aachen, Germany.

Spikings, R.A., B.P. Kohn and D.A. Foster. 2000. 40Ar/39Ar and apatite fission-track thermochronology of Palaeoproterozoic cratons in NE Australia. *In* W.P. Noble, P.B. O'Sullivan and R.W. Brown eds. 9th International Conference on Fission Track Dating and Thermochronology, Lorne. Geological Society of Australia Abstracts No. 58:297-299.

Stefani, C., M. Zattin and P. Grandesso. 2004. Petrographic signature of Paleogenic turbiditic sedimentation in north-eastern Italy. 32nd International Geological Congress, Firenze, Italy.

Thiede, R. B. Bookhagen, R. Arrowsmith, M. McWilliams, E. Sobel., M. Strecker. 2003. Distribution of orographic precipitation guides exhumation along the Southern Himalayan front in NW India. AGU Fall meeting, San Francisco, California.

Thiede, R.C., R. Arrowsmith, B. Bookhagen, A.K. Jain, M. McWilliams, S. Seigh, E.R. Sobel, and M.R. Strecker. 2004. Spatially concentrated erosion focuses deformation within the Himalayan orogenic wedge: Sutlej Valley, NW Himalaya, India. AGU Fall meeting, San Francisco, California.

Thiede, R. B. Bookhagen, R. Arrowsmith, E. Sobel and M. Strecker. 2004. Climate control on rapid exhumation along the Southern Himalayan Front. Sediment 2004, Aachen, Germany.

Thiede, R. B. Bookhagen, R. Arrowsmith, E. Sobel, and M. Strecker. 2004. Does the distribution of orographic precipitation and fluvial erosion guide exhumation patterns along the Southern Himalayan front, NW India? Geophysical Research Abstracts, Vol. 6, 05115, Sref-ID: 1607-7962/gra/EGU04-A-05115, European Geosciences Union, Nice, France.

Thiede, R.C., R. Arrowsmith, B. Bookhagen, A.K. Jain, M. McWilliams, S. Seigh, E.R. Sobel, and M.R. Strecker. 2004. Spatially concentrated erosion focuses deformation within the Himalayan orogenic wedge: Sutlej Valley, NW Himalaya, India. AGU Fall meeting, San Francisco, California.

Thiede, R.G., E. Sobel, R. Arrowsmith, B. Bookhagen and M. Strecker. 2004. Climate and orogen driven denudation across the Himalaya, NW-India. 10th International Fission Track 2004 Conference, Amsterdam, Netherlands.

Thomson, S.A., M. Zattin, P.W. Reiners, and M.T. Brandon. 2003. Cross-comparison of the apatite fission-track and (U-Th)He thermochronologic systems in post-depostional reheated sedimentary rocks. GSA Annual Meeting, Seattle, Washington.

Thomson, S.N. M. Zattin, M.T. Brandon and P.W. Reiners. 2004. A regional synthesis of low-temperature thermochronologic results from the Northern Apennines, Italy: a key to understanding syn-convergent extension and erosion in an orogenic wedge. 32nd International Geological Congress, Firenze, Italy.

Wijbrans, J.R. and C.G. Langereis. 2003. Elusive Gilsa: Finally laid to rest in northeast Iceland. EGS Meeting. EAE03-11595. Nice, France.

Wijbrans, J.R. and C.G. Langereis. 2003. Basalt Chronostratigraphy of NE Iceland: Implications for the Geomagnetic Polarity Time Scale. Abstract. Fall AGU, San Francisco, California.

Zattin, M. S.N. Tomson, P.W. Reiners, M.L. Balestrieri and M.T. Brandon. 2003. Investigating neogene exhumation of the Northern Apennines by combining fission-track and (U-Th)/He dating in areas of high relief. GSA Annual Meeting, Seattle, Washington.

Zattin, M., L. Aldega, D. Bersani, S. Corrado, C. Invernizzi and S. Mazzoli. 2004. Multisciplinary constraints to the apatite annealing temperatures: a case history from the southern Apennines. 10th International Fission Track Conference, Amsterdam, Netherlands.

Zattin, M., J. Brain, M. Brandon, P. Isaacson, and P.W. Reiners. 2004. Thermal-topographic modeling of the Northern Apennines. 10th International Fission Track Conference, Amsterdam, Netherlands.

Zattin, M. M.T. Brandon, M.L. Balestrieri, P. Reiners and S.N. Thomson. 2004. A multichronometer approach for unraveling the exhumation history of an active orogen: the example of the Northern Apennines (Italy). 32nd International Geological Congress, Firenze, Italy.